Engineering Record

A Weekly Journal Devoted to Civil Engineering and Contracting

Published by McGraw Publishing Company, Inc.

Volume 73 NEW YORK, SATURDAY, FEBRUARY 12, 1916 Number 7

The Center of the Stage

NEXT week the concrete cohorts will meet in Chicago, drawn thither by the Second National Conference on Concrete Road Building, the Cement Show and the convention of the American Concrete Institute. It will be an extraordinary opportunity to get in touch with those whose thoughts and work deal with concrete, to learn of the latest ideas in organization, plant and methods. If the concrete road conference repeats the success of two years ago, it alone will be worth the expense and sacrifice of attendance, no matter how great they may be. The Cement Show has long since established itself with engineers and contractors alike and can be counted on to deliver full value. The concrete institute presents an extraordinarily good program, despite the vicissitudes it has passed through. While not generally known, the institute's fate—whether it will live or pass out of existence—will probably be decided at Chicago, or at least will be determined as a result of interest or lack of interest there displayed. The institute has been on the verge of extinction before, but the present crisis seems to be the most severe. It will be a serious loss if the organization must be abandoned—not indeed a loss if compared with recent performance, but a loss of a great opportunity that was and still may be made available. Altogether, then, the week is a most important one to the contractor and the engineer interested in concrete. Much good will come of it, even if no way is found to put the institute on a permanent basis.

A Cement Issue

AS NOTED in the preceding paragraph, the leading topic of interest in the engineering world next week will be concrete—the loadstone which will attract engineers and contractors to Chicago. Conforming with the spirit of the coming week, this issue is devoted to descriptions of some important concrete work. Mr. Breed's story on a very unusual concrete-road building plant, Mr. Poole's description of the largest Imhoff sewage plant in the United States, and the quay-wall design at Halifax will be found of special interest.

Condemnation of Water Power

LATE last month the Supreme Court of the United States handed down a decision relative to the condemnation, under state law, of water power in Alabama. The contention of those opposing the condemnation was that it contravened the fourteenth amendment of the Constitution. The Supreme Court holds that such is not the case. On the main question raised, that the purpose of the condemnation was not a public one, the court declares: "In the organic relations of modern society it may sometimes be hard to draw the line that is supposed to limit the authority of the legislature to exercise or delegate the power of eminent domain. But to gather the streams and rivers from waste and draw from them energy, and so to save mankind from toil that it can be spared, is to supply what, next to intellect, is the very foundation of all our achievements and all our welfare. If that purpose is not public we should be at a loss to say what is." The decision plainly ends any dispute as to the right of states to pass statutes permitting the condemnation of lands, water and water rights for the purposes of power development.

Minnesota Rate Decision—A Panacea

WHEREVER valuation is discussed, whatever the phase, whatever the side argued, it seems that the Minnesota rate decision proves the point. To the state commissions it proves that no more than the market value of land can be allowed as present value. To the railroads it proves only that pyramided multiples and percentages are taboo. To the state commissions it shows that reproduction cost is no longer to be seriously entertained. To the railroads it shows this to be the main basis of value. The most innocent expressions are made to mean as many things as there are views. For instance the word "assuming," as in the clause, "Assuming that the company is entitled to a reasonable share in the general prosperity of the communities which it serves," the railroads interpret to mean "assuming"—just what it says. The state commissions, however, find that it means "If it were, but it is not." Verily it is about time to concede that the Minnesota rate decision settled immutably the Minnesota rate case and little else, and take up the discussion of reproduction cost from the simple standpoint of right and wrong.

Halifax Quay Wall

AS A RESULT of thorough study of the local conditions at Halifax and of the works at other ports, the engineers responsible for the new ocean terminal at the Canadian city have developed something unique in quay-wall design. This could have been expected from the exhaustive comparative studies which were made. A description of them will be found on page 213 of this issue. The Halifax wall combines the advantages of the solid concrete-block with the rubble and mass-concrete types. This is evident from the stability of the completed structure and from the rapidity and success achieved in construction. The square reinforced-concrete guide columns; the use of open compartments and spaces between the blocks, to be filled after they are in position with either mass concrete or rubble; the grout holes to bond the blocks; and the use of a cut-stone retaining wall at the top between high and low-water levels, to prevent disintegration, are all evidences of the thoroughness of the work of the designers. The use of corner stools of carefully leveled concrete, prepared under a diving bell, to avoid the necessity of leveling the whole rock bottom, is one of the simple and effective features which resulted in great saving in time and cost. Engineers interested in the quay-wall design will find many suggestions both in the article in this issue and in the one on construction methods, published on page 143 of the issue of Jan. 29.

A Plea for an Open Mind

AS WAS to be expected, the plan to move the headquarters of the American Society of Civil Engineers to the Engineering Societies Building is already being widely discussed. It is to be hoped, for the good of the society and of the profession, that every phase of the question will be carefully reviewed. Yet there may be some who will close their minds and vote without giving the matter careful thought. One such was encountered by the Engineering Record early this week—an engineer of ability, who in this matter, has not displayed the fairness for which he is noted. Upon being asked his views on the advisability of the change in headquarters, he stated that he had opposed the removal thirteen years ago, was opposed to it now and had cast his ballot negatively immediately upon its receipt, lest someone might persuade him to vote in favor of the proposal. He went on to say that the American Society of Civil Engineers was sufficient unto itself—had all the money it needed and a good building where it could meet as it would. Upon protest that this was a selfish point of view and gave no thought to the possible advantages to the profession at large, he admitted without a quiver that such was the case. The Engineering Record trusts that there are not many who take the same attitude, and it submits that those who do are out of harmony with the spirit which induced the board of direction of the society to submit the proposal again to the membership. The resubmission necessarily implies that there is new evidence, that the situation is sufficiently different now from what it was thirteen years ago to warrant careful reconsideration by the members of the society. Certainly the least that any member can do is to consider the proposal carefully and with an open mind before casting his ballot.

Park Lands and Engineers

TWO Eastern cities are at present the scenes of controveries over the invasion of park lands by engineering structures. In Washington objection is being made to the location of a central heating and power plant near the Mall and in the neighborhood of the Washington Monument, while in New York there is strenuous protest against a pumping plant being erected by the Board of Water Supply in Morningside Park. In Washington not only architects but engineers as well have appealed to the authorities to change the site. At New York, so far, only taxpayers, real estate interests and the newspapers are advancing arguments against the use of the park property. Engineers generally, we have no doubt, are in hearty sympathy with the general principle prompting the present protests, namely, that park property—land set aside for the refreshment of the people and for recreation purposes—should not lightly be devoted to any other ends. The Washington case seems to be particularly flagrant. In the New York situation we have the assurance of the chairman of the Board of Water Supply that the engineers have considered and rejected alternative designs, but his statement is not convincing. A careful presentation of the situation by the engineers, with a full explanation of the alternatives considered and the reasons for their rejection, is a necessary step in settling the controversy to the satisfaction of the citizens. Both situations involve engineering structures, and it is but right that engineers should take an interest in securing a correct ultimate solution. If weighing of all factors shows that the Catskill structure can be placed nowhere else and cannot be put underground public necessity justifies the park site.

Port Development

TWO MAIN arguments concerning port development were put forth in the address of Fairfax Harrison, abstracted on page 209, at the recent Foreign Trade Convention in New Orleans. One is the fairly familiar one that ports should develop and administer their own facilities and collect from the traffic instead of from the railroads. The other is the rather new doctrine that we should concentrate on a few selected ports. The arguments for putting the responsibility for the terminal facilities on the port itself are many and strong. Their presentation by a railroad man seems to indicate a change of viewpoint since the day when each road felt it necessary to provide exclusive facilities better than those of any of its competitors. It is well that the railroads are coming to see the folly of this costly duplication of plant. As to the selecting of a few ports for development, while this would undoubtedly make for economy, it seems too Utopian to be realized. What ambitious port with a tolerable harbor and pier or two would forego its efforts to expand merely because a neighboring place was better equipped? Mr. Harrison implies, of course, that the railroads could force the situation if they were allowed to discriminate in favor of those ports best suited to their needs—or, from their point of view perhaps, to cease discriminating in favor of the weaker ports. If they were given more liberty here, however, the next logical step would be to extend the policy to the inland communities. The Engineering Record does not say that they should not be given more license in this respect. But the question is one involving the whole rate structure and the theory of rates; abuses are easily possible if a free rein is given, and it does not appear that public sentiment will allow it in this generation.

Part of Original Cost

SPEAKING for the state public service commissions at the recent valuation conference in Washington, W. A. Shaw of the Illinois commission—unintentionally, of course—gave an excellent argument against original cost as a basis for value. He stated that after a railroad is opened for traffic the work of putting the line into the best operating condition, widening ditches, trimming shoulders and the like has generally been done by the maintenance forces and charged to operating expenses. This is perfectly true—and it is equally true that the expense is part of original cost. Ergo, the original cost indicated by the books, which take no account of this item, is not original cost at all. The misgivings of the railroads on the subject of original cost are probably not so much on the score of the figures for the main items of construction, which either do or do not exist, as on account of the myriad of comparatively small items for finishing the original construction and making the gradual improvements that have been going on ever since. Probably the existence itself of many of these items will never be known. It does not meet the case at all to say that whatever these expenses were they were charged to operation, and that to add them to value would be to charge the consumer twice for the same thing. Naturally expenses must be paid somehow, if there is any money anywhere to pay them. The fact that in the old days, when accounting rules were loose, additions and betterments were paid for out of income, does not by any means prove that income could afford to pay for them and still yield a reasonable profit.

Concentration of Water-Power Control

THE BUGABOO of a water-power trust has been raised again by the publication of the report, submitted to the Senate by the Secretary of Agriculture, showing the relations of the companies owning water power in the United States. The report was briefly abstracted in the last issue of the Engineering Record, page 192. From various quarters have come expressions of fear that the people of the United States either now or later are to be at the mercy of the octopus. Granting that eighteen corporations control more than one-half of the total water power used in public-service operations in this country, and that six corporations control more than one-quarter, what need is there for alarm so long as the state utility commissions have control over the rates. In other words, no matter how extensive the monopoly, the return to it from the ownership of the water powers remains in control of the people. Such is not the case, of course, where the entire power produced at a particular point is used by a single corporation for industrial purposes. Yet it is not these powers that are discussed in the report in question.

That the report itself recognizes the advantage of monopoly is apparent from the following passage:

"Monopolization of the supply in any given territory makes possible, through interconnections of stations and through diversification of load, economies of operation that would not be possible for isolated independent stations. Interruptions to service may be lessened, the needs of the customer may be better served and rates may be lower with a single power system than with several. No better service is given and no lower rates charged than in California, where, notwithstanding the considerable municipal developments, 90 per cent of the total primary power is used by public-service corporations, or in Montana, where 89 per cent is owned by two affiliated corporations. Having the ability to give the better service and the lower rate, it only remains for the proper public agency to require it."

It is right here that the case of the agitators who hold up the water-power trust bugaboo falls to pieces, because the proper public agency to require reasonable rates is already provided in the various public-service commissions which now regulate electric utilities in all but fifteen states.

Centralized Control Over River Pollution

IN his recent address before the Michigan Engineering Society Prof. Earle B. Phelps, of the U. S. Public Health Service, speaking of the work of the International Joint Commission, decried the current practice of making the control of river pollution a state, rather than a federal, obligation. There has resulted from this condition, he said, many divergent, unrelated and even conflicting laws and court decisions, and a variety of practices in the various states, ranging from the most stringent laws and control to a complete disregard of the whole subject. Were single state jurisdictions coextensive with the principal river systems of the country each state would doubtless work out its problems to its own best interests. Unfortunately quite the reverse is true and all of the more important river systems, of the eastern half of the country at least, are either interstate or flow from one state into another. In addition we have as an international boundary on the north our greatest of inland water systems, the Great Lakes and their connecting rivers. This situation has been by far the most potent factor in our disregard of the problems of stream sanitation, leading to the present unsatisfactory conditions in many of our most valuable streams.

With the present system of regulation it is natural that there has grown up the feeling that, in case of interstate streams, local effort is of no avail. There being no medium of communication and agreement between states in such matters, a do-nothing policy has in most cases prevailed. The interstate character of its two principal streams has, in the case of Massachusetts, even been made the excuse for exempting those two rivers from the workings of an otherwise excellent system of stream control. Upon the plea that these rivers enter the state somewhat polluted, the state permits unlimited and harmful pollution within its borders to the detriment of its own people. In the central states the presence of the great interstate rivers has either discouraged legislation altogether or induced a tacit understanding that these rivers are exempted.

The question of our international waters might appear to be even more complicated, but fortunately in this case the treaty-making powers of the governments have provided a possible remedy and one which is not without significance. It is probable, therefore, that when the International Joint Commission finishes its work, there will be available concrete evidence of the desirability of centralized control which can be used to advantage to improve conditions as they now exist.

Fallacies Regarding the Crystallization of Steel

AMONG the Letters to the Editor in last week's issue is one which disagrees with the editorial on the subject of the crystallization of steel in The Engineering Record of Jan. 8, page 35. The alleged "evidence" adduced in the letter is of too general a nature for acceptance in support of the theory of the cold crystallization of steel under service conditions. That theory, which has so long served as a scapegoat for so-called mysterious failures of steel, flatly assumes that, because the fractures in such cases commonly exhibit a crystalline structure, the material has been reduced to that state under repetitive stress, with accompanying vibrations, the latter being usually designated more or less vaguely as the active agent in producing the alleged deterioration.

If this scapegoat theory is not in reality a mere bug-bear, it is high time that its validity should be established in a convincing way. From the present lack of affirmative evidence it may be fairly held that this so-called theory is purely chimerical, nor do the facts recited by our correspondent suffice to alter that position.

His observations and deductions, briefly summarized, are that certain steel studbolts which had been screwed into the outside sheets of steam locomotives could be knocked off, in the case of old boilers, by a single blow from a hand hammer. The fact that these bolts could be thus broken off is advanced as proof of their brittleness, and the circumstance that the fractures exhibited always a crystalline structure is offered inferentially as evidence of their having crystallized in service. Incidentally, the correspondent calls attention to the fact that these bolts had been subjected "to great variations in temperature and to extreme vibrations," this statement being obviously too indefinite to admit of critical deductions. Again, such pertinent matters as the character of the steel, the size of the bolts, the weight of the hammer and the height of the swing are not mentioned.

That the crystalline structure of steel and its ductile properties may be changed, within wide limits, by the familiar processes of tempering and annealing, and that such changes may be brought about under abnormal and very exceptional service conditions, wherein the material is exposed to peculiar heating and cooling influences, is, of course, not to be questioned. That consideration has, however, no bearing, direct or indirect, on the so-called theory of cold crystallization of steel, to which the editorial excepted to is addressed.

A steel bolt, ruptured in the screw threads under the blow of a hammer, will invariably show a crystalline structure, so that the latter is in no way indicative of deterioration. It is a well-known fact that if a V-shaped notch be cut in a steel bar, and the bar be broken in bending by means of a sledge hammer, with the notch on the tensile side of the beam, the fracture will be crystalline.

Again, if a sharp V-shaped notch be turned in a bar of soft steel, and, if the latter be broken in tension at this notch, under gradually applied loading, the structure will also be crystalline; whereas, if the same bar be broken, under like conditions, in the ungrooved parts, the structure will show the silk or finely granular texture characteristic of normal steel as ordinarily tested. The explanation lies in the fact that, in the former case, the stresses are localized by the groove, and no opportunity is given for the material to draw out gradually, as in the latter case.

It is to be confidently assumed that, unless the temperature conditions vaguely referred to by our correspondent were of such a pronounced character as to change the crystalline structure of the metal, the bolts in their original state would have shown the same behavior and given precisely the same indications as in their final state, as described in the letter. It may at least be said with entire safety that his contention remains *unproved.* His observations are, indeed, on a par with others that have frequently been reported, and to which the origin and persistency of the theory of cold crystallization of steel is directly attributable.

It is, perhaps, unnecessary to point out that this discussion has no bearing whatever on the question of the progressive fracture of steel under repetitive loading, commonly referred to as "fatigue," but attention may again be directed to the fact that investigations in that field do not give evidence of changes in the crystalline structure of the steel, save in the immediate vicinity of the fracture, due to the shear slips in the crystals.

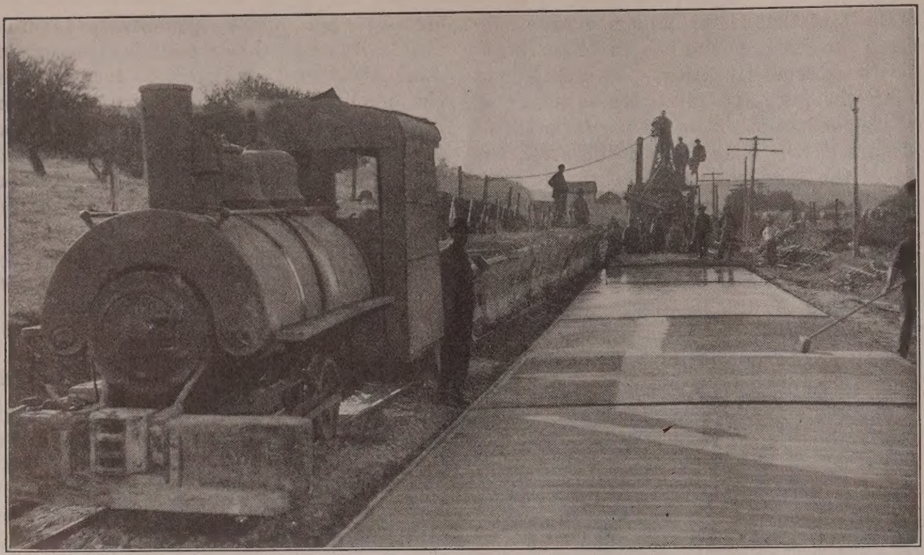
To sum up, there exists, it is believed, no evidence that stresses, accompanied by vibrations of the members subjected to these stresses, but not by temperature influences, will affect the crystalline structure of steel, although it is doubtless true that, if the amplitude of the vibrations and their frequency are such as to induce conditions of stress similar to those which would eventually cause failure under repetitive loading, such failure may also be expected to occur under the former conditions, unaccompanied, however, in either case, by changes in the crystalline structure of the material, save in the region of fracture.

A Word of Thanks and a Pledge

THE ANNOUNCEMENT on the front cover of this issue of an increase in the subscription rate of the Engineering Record makes opportune a word of thanks from the editors to the engineering profession and to contractors for the generous support they have received. The contemplation of the Engineering Record's progress during the past thirteen years cannot but bring a feeling of satisfaction to those who have guided its policy, even as it daily elicits unstinted praise from readers. The improvement of the paper, in the last analysis, is attributable, first, to the ideals set up when the property was acquired thirteen years ago, and, second, to the confidence of the publishers that American engineers and contractors would warmly support a journal of the type planned. The publishers wanted a paper that should be broadly professional, and not merely technical; that would be vigorous and fearless editorially; that in virility, resourcefulness and energy would be typical of the clientele it was designed to serve. The plans, therefore, provided for a paper that should expand in any direction that promised better service to the field, that should be of as great value to the contractor as to the engineer, that should be accurate and timely in reporting engineering and contracting news, that should, in a word, set the pace and the standard of American engineering journalism. That the field has approved of this type of journal is clearly shown by the growth in circulation from 3000 in 1903 to 20,000 in 1916.

But while the development was going on, and during the past five years in particular, it has been appreciated that the subscription rate would have to be raised. It was merely a matter of time when the change should come, and the present year, with business on the upward grade, seems opportune. The publishers announce the increase with full confidence that its justification will be seen by engineers and contractors, and that the response will indicate that the publishers were right when they determined thirteen years ago to set new standards in engineering journalism.

To those who have watched the Engineering Record's progress, a word as to the future is entirely unnecessary. They know that it will continue in the forefront, that it can be counted on to lead in service to the engineer and contractor. The publishers, nevertheless, are glad to pledge themselves to a continuance of the policies that have brought the Engineering Record to its present high place. The leadership that has been won will be maintained.



FINISHED PAVEMENT SHOWING LINES MADE BY BROOMING

Concrete Road-Building Methods Yield Profits in Cash Instead of in Plant

Contractor Reduces Labor Costs by Mechanical Handling of Materials Used on New York State Highway Section

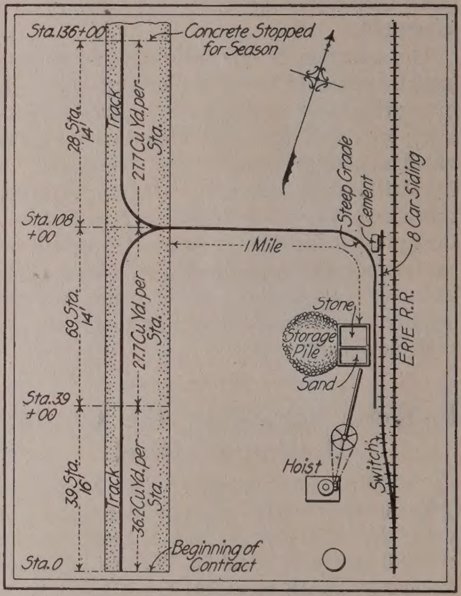
By H. E. BREED
First Deputy Commissioner, New York State Highway Department

PROFITS in cash, instead of in plant, were realized by the contractor on the Little Valley-Cattaraugus concrete road of the New York State highway system, where the problem of machinery versus labor was solved by economical methods of handling material. Three distinct advantages for the contractor can be summed up in this piece of work. His plant is the kind in common use and can be procured easily new or second-hand, or ofttimes rented. Being in general usage, it has higher salvage value than average plant and therefore larger margin for cash profits. And lastly it materially reduces man labor, strikes and other industrial troubles. The substitution of machinery for man labor progresses the work more rapidly, which is of distinct advantage both to contractor and public at large.

MACHINERY VERSUS MEN

During the past year the quality and quantity of labor has decreased for several reasons. The European war has checked immigration and withdrawn many of our laborers. The manufacture of munitions and the great output in the steel and mining industries have demanded large forces. With the adjustment of monetary conditions has come an increase of development and improvement work that has well-nigh exhausted the available supply of men. In order to cope with this scanty, risky and rising labor market, it has become necessary for those who, in competing for work, would allow themselves a reasonable margin of profit, to lessen the need of man power by substituting for it other methods of construction.

While the efficiency of labor has lessened, that of equipment has increased. Obviously the contractor must depend more and more upon machinery, but in this transition to a new form of construction he will consider several things. Can his ingenuity devise some means of cheapening the work that other competitors will overlook? How much will he save? Will his profits be real or plant profits? In other words, will he have actual cash or only increased plant to show for his work when it is done?

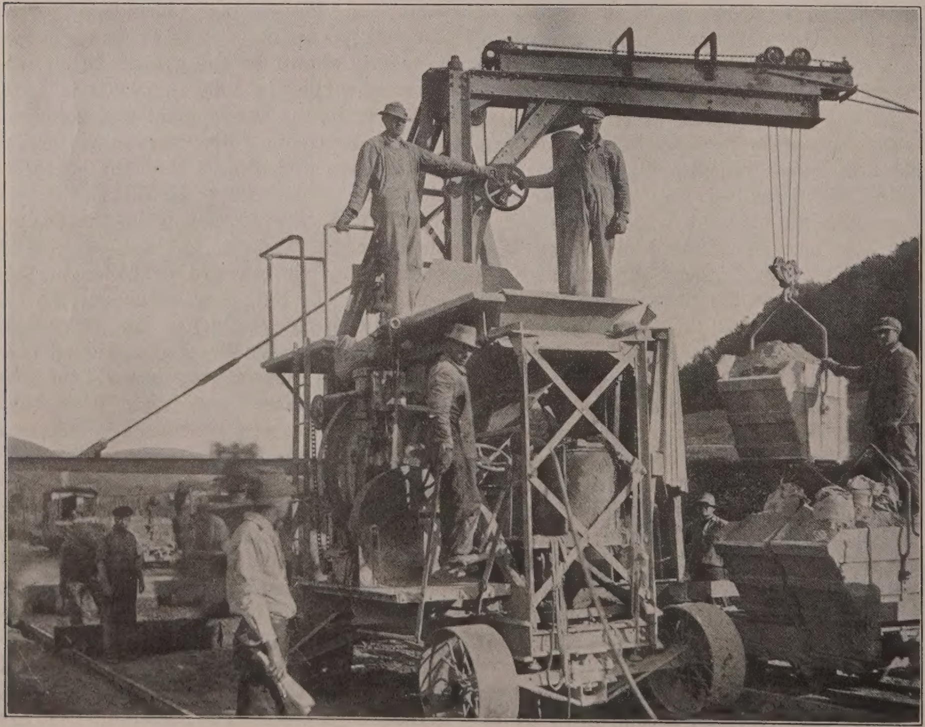


LAYOUT OF CONTRACTOR'S PLANT FOR CONCRETE ROAD CONSTRUCTION

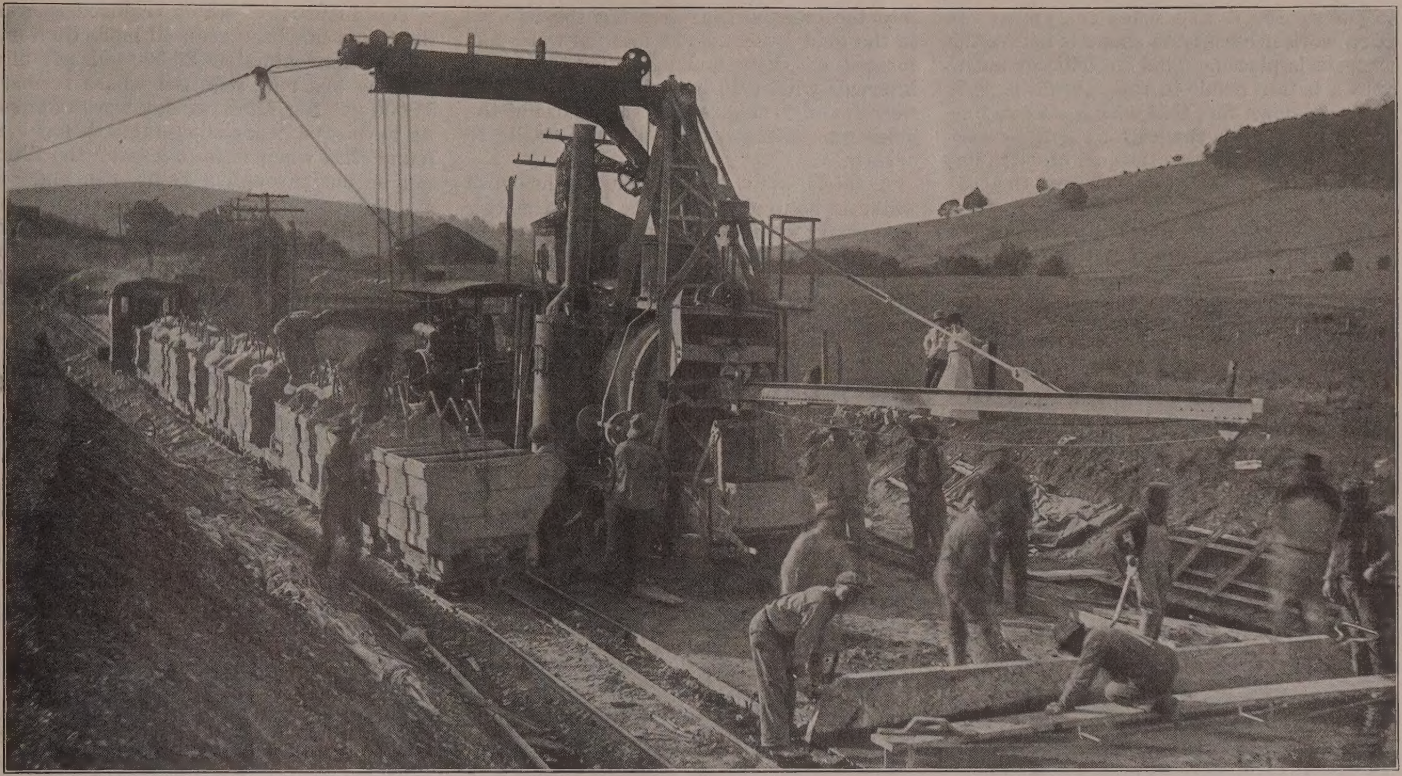
Many contractors have gone to the wall because their profits were in plant instead of in cash. It is dangerous to equip any piece of work so that, on its completion, unsalable plant is left on the contractor's hands, unless he has included the entire cost of the plant in his bid cost of the work. If, on the other hand, the plant shall be readily salable, then only the excess of original cost over the salvage value, plus interest, repairs and depreciation, need be charged as a plant item against this particular piece of work.

PLANT LAYOUT

The plant layout used by the contractor on the Little Valley-Cattaraugus road is shown in the accompanying drawing. The location of the railroad, the siding, cement house, sand and stone bins, storage pile, water tank, and clam-shell hoist are indicated, together with the track, industrial railway and the line of improvement. This takes in about one-half of the work of the contract, and on this basis, from all indication, it looks as if the contractor would profit to a greater extent than if he had used labor. Labor, of course, was not entirely eliminated on this work, but it was lessened by about 15 men formerly used in shoveling material into barrows and wheeling it to the mixer, as well as by the number of men formerly necessary to do the



BOOM ON MIXING PLANT PICKING UP WOODEN BUCKET ON WHICH CEMENT HAS BEEN PLACED



CONCRETE AGGREGATES WERE DELIVERED BY DINKEY TRAINS ON INDUSTRIAL TRACK PARALLELING ROADWAY

work of unloading the materials from the cars, such as cement, sand and stone.

A general idea of the plant may be had from the photograph which shows the bins, stiff-legged derrick and hoist, with stock pile. Immediately back of the bins is noticed the dinkey engine at the head of a train made up for materials. Directly beyond is the standard freight car on the Erie Railroad siding.

UNLOADING PLANT AND BINS

The unloader kept the bins full at all times, handling material from the cars to the bins when possible, and to the stock piles if the bins were full, or from the stock piles to the bins if no cars were at hand. These stock piles almost eliminated the demurrage on cars. They also permitted the work to be continued if there happened to be such congestion as prevented material from arriving promptly. The extra cost of handling into the stock pile, and from stock pile into the bins, is more than recompensed by the continuity of the work at all times and the elimination of the idle or standing cost. The underside of the bin is equipped with two hoppers, one for stone and one for sand. They are provided with shut-off doors so that each may carry the desired amount of materials for a four-bag batch of concrete at the mixer. By opening the lower end of these hoppers simultaneously the stone and sand are mixed when entering wooden boxes which contain enough for one batch. These boxes were a part of the contractor's home-made equipment and were built for this work in particular.

Coal was also unloaded by the derrick and transported by the dinkey trains and Koppel cars. Sufficient cement for each train load was carried in two industrial steel cars.

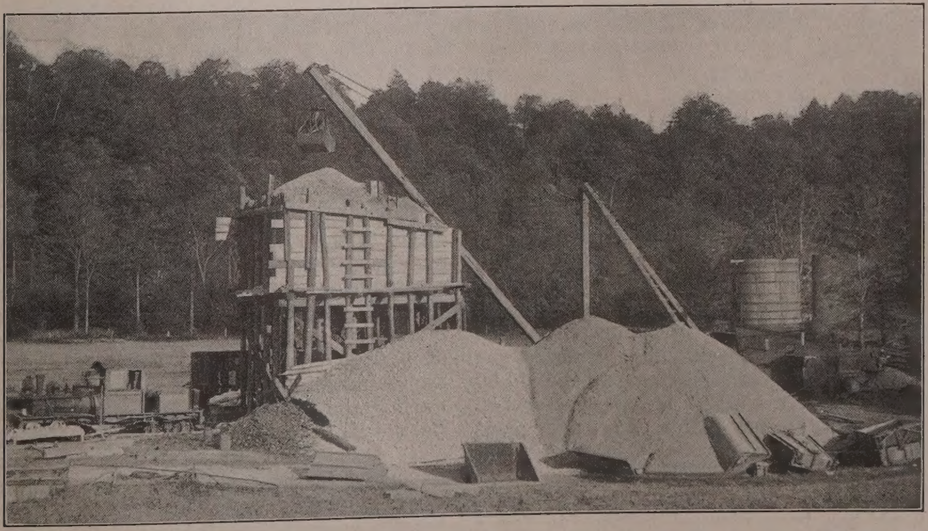
The average number of men used at the unloader is five laborers and one hoist runner. In the old way from sixteen to twenty men would be required to do the same amount of work. The average haul for the portion completed last summer was 1.95 miles, as indicated in the drawing. About 1000 ft. of the track between the unloader and the road was over a swamp and up a fairly steep grade. This grade resulted in the stalling of some trains, and it was necessary to provide an extra dinkey engine to be sure of handling the trains properly. It would have been good economy to have reduced this grade in such a manner that the two engines could have handled this work without using the additional one.

SPECIAL BOOM ON MIXER

The average train contained thirty wooden buckets for thirty batches with a sufficient amount of cement. This required about eight trainloads a day, the average force being three dinkey engineers, one foreman and two laborers. On the basis of the work done last summer the yard cost per mile haul was 5.65 cents, exclusive of coal and plant charges.

In one of the illustrations the boom is picking up a bucket on which the cement has been placed. The further operation of this bucket from the train to the hopper of the mixer is more clearly indicated in another, close-up view. These two pictures also show the location of the track with respect to the pavement and the construction details of the buckets used for carrying the material. The mixer is equipped with a boom for handling the buckets, which are dumped by a single trip on the iron handle. The man on the lower platform operates the hoisting mechanism. The boom at the present time is moved sideways to a position above the bucket by two men. It is the intention to operate it mechanically before next year's work begins. The views indicate the number of men required to place the concrete and something of the method of screeding and finishing the surface. The mixer used was a ½-cu. yd. Austin.

The sub-grade ahead of the machine, which is kept free from all material, can be carried so close that after rolling there is



MATERIAL HANDLING EQUIPMENT — BINS, STIFF-LEG DERRICK AND HOIST, AND DINKEY ENGINE WITH INDUSTRIAL CARS—STOCK PILES IN FOREGROUND no chance for it to become cut up, nor is extra work necessary to shape it before the concrete is placed. This contributes largely to a better result in the pavement, as it is a well-known fact that with a smooth subgrade there is less chance for surface cracking. It also eliminates the cost of extra finishing of the sub-grade just before the concrete is placed.

In the view of the finished pavement the lines in the foreground are the results of brooming. In the manipulation gang there are, on an average, one foreman, one fireman, one mixer engineer and fifteen laborers, while on the fine grading and forms there are one foreman and an average of three laborers. The batch used was a four-bag one. The type of dumping bucket has the advantage of placing the concrete on the road in excellent shape. The water tank for the mixture is capable of fine adjustment and consequently gives a very uniform mix.

Grid Above Filter Surface Saves Wash Water

New System of Auxiliary Wash Shows Definite Economies and Eliminates Recourse to Fire Hose Stream

AN AUXILIARY grid above the sand in the iron-removing filters of the Champaign & Urbana (Ill.) Water Company saves 10,000 gal. of wash water per filter daily. Considerable difficulty was experienced in the early period from fouling of the sand bed following the installation of the filters in 1913. A description of the plant and its operation appeared in the Engineering Record of April 11, 1914, page 419. F. C. Amsbary, manager of the company, presented at the meeting of the Illinois section of the American Waterworks Association, Jan. 26, the following information regarding his experience:

It had been the custom at the plant to use a fire hose on the surface of the filters whenever they became so clogged up that they would not last through a 15-hr. run with any degree of efficiency. This seemed to tear the floc loose and clean up the sand bed so that the filters could be used for several weeks again when the same operation had to be repeated.

The benefits resulting from the use of a fire hose upon the filter bed demonstrated the possible applicability of a high pressure wash regularly applied to the top of the bed. W. W. DeBerard, Western editor of the Engineering Record, suggested, during the meeting of the society in March, 1914, a high-pressure grid placed a few inches above the sand bed while the latter was at rest, but which would be submerged in sand when the wash water was applied to the underdrains. This method had been tried out at Oakland and found to work in a very efficient manner. Accordingly, during July, 1914, an experimental grid was placed in one of the Champaign & Urbana Company's filters. After six months' trial the effectiveness of this grid was so evident that similar grids were placed in all of the filters.

DETAILS OF SYSTEM

The grid system, as installed for experimental purposes, consisted of two parallel manifolds made up of 4-in. nipples, 15 in. long, and 4 x ¾-in. crosses. Lengths of ordinary ¾-in. galvanized iron pipe, 2¾ ft. long, capped at the outer end, were screwed into the crosses, thus forming the laterals to the grid system. The laterals were perforated on their under surface at 12-in. intervals with 1/16-in. holes. Perforations were found to clog rapidly so the size of the holes was enlarged to ⅛ in. and finally to 3/16 in.

A fairly even distribution of the wash water is secured. There is approximately one perforation per square foot of filter area. The discharge through the grids is estimated at one-third the discharge through the underdrains.

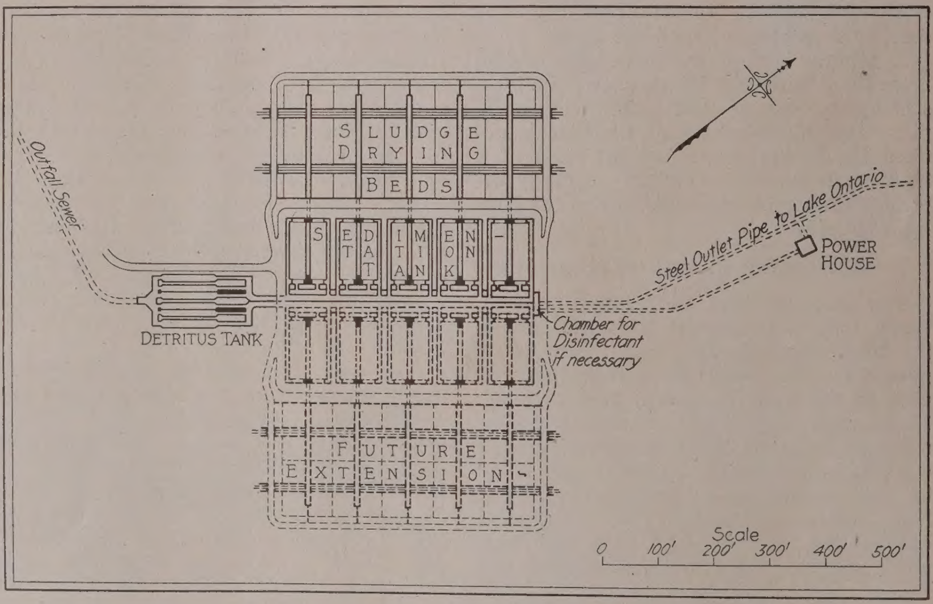
The quantity of water required to wash the filters has been reduced more than one-third. Approximately 25,000 gal. per filter per day are now required where formerly 35,000 gal. per filter per day were required. As to the frequency of washing, it has been found that when it is necessary the filters can be put through a 24-hr. run and still maintain a fair degree of efficiency. Formerly at the end of an 18-hr. run the sand bed would be almost impervious. Frequent analysis of the effluent shows an average iron removal of 95 per cent.

Largest Imhoff Tank Plant Nearly Ready to Treat Rochester's Sewage

Concrete Construction Finished on Six Detritus Tanks and Ten Sedimentation Units Having Exceptional Sludge-Storage Capacity

BY C. ARTHUR POOLE
General Assistant, Department of Engineering, Rochester, N. Y.

EXCEPT for the installation of the operating equipment, the sewerage and treatment works at Rochester, N. Y., the largest single Imhoff tank plant in the country, was completed at the beginning of this year. Involving an expenditure of about $2,000,000, the city's large-scale improvements, which have been under construction since 1911, include 7 miles of interceptors and conduits, 1 1/3 miles of submerged outlet, six detritus tanks, fine screens, and 10 Imhoff tanks, with provision for ten more when future needs require them. The work was undertaken to relieve the pollution of the Genesee River by crude sewage, and under the new plan of collection and disposal the effluent will be discharged into Lake Ontario. The design of the Imhoff tanks is rather unusual, in that it provides for unusually large sludge storage capacity and increased gas vent compartments, making the individual tanks of exceptional size. Another special feature is the installation of a power plant utilizing the head available in the effluent from the tanks to develop power sufficient to light and operate the plant. The entire work has been planned to provide for a future population of approximately 450,000 people living within the territory tributary to the sewage-treatment system.

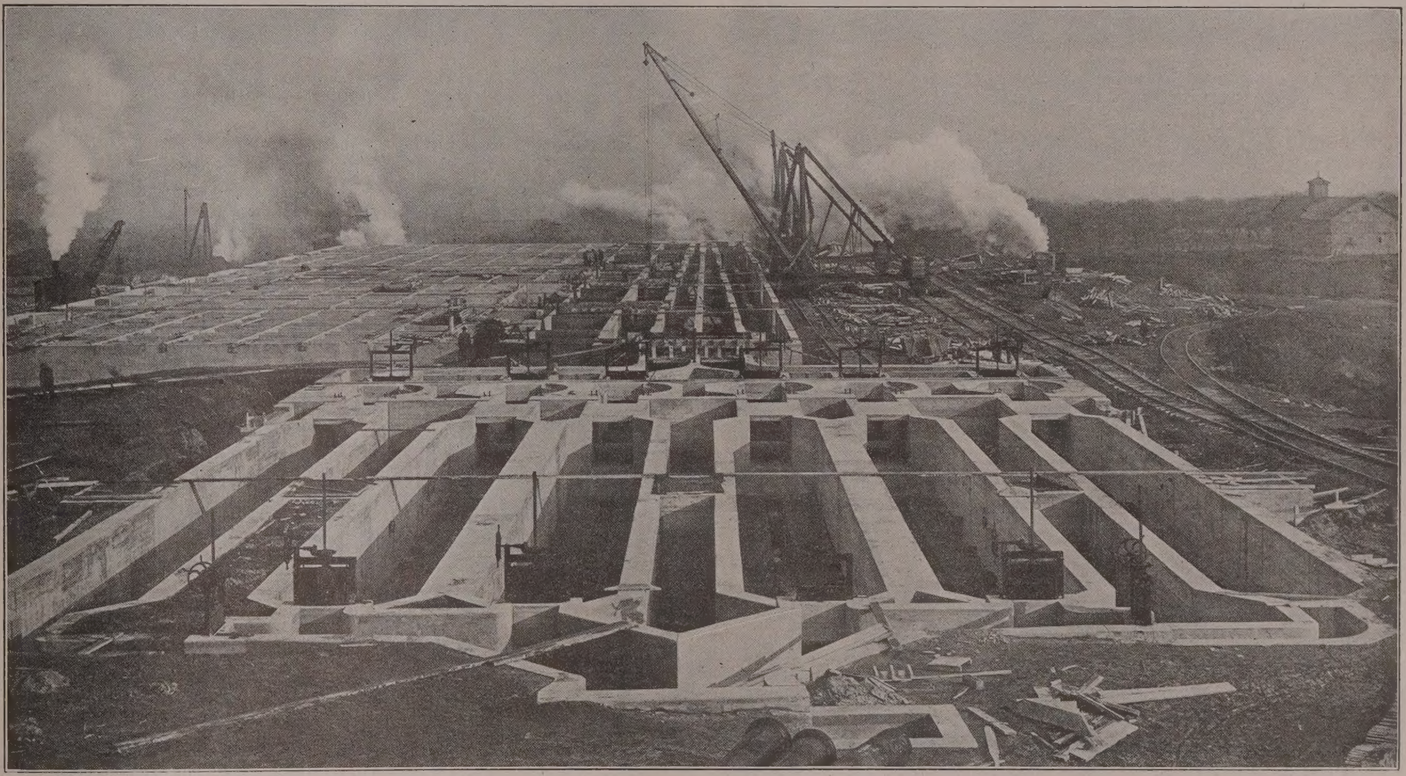


TREATMENT WORKS ARE ON 290-ACRE PLOT AND CONSIST, AT PRESENT, OF SIX DETRITUS TANKS, REVOLVING SCREENS, TEN IMHOFF TANKS, AND SLUDGE-DRYING BEDS

HISTORY OF INVESTIGATIONS

As early as the year 1889 the question of the future disposal of the sewage of the city was being considered, at which time the late Emil Kuichling, consulting engineer, made a study and report of the conditions. The flow in the Genesee River at that time, and for some years afterward, was adequate to dilute the sewage sufficiently to prevent any complaints of contamination. With the growth of the city and an increased volume of sewage the condition of the river continually grew worse, numerous complaints were made and several damage suits were begun, so that in 1904 Mr. Kuichling was again employed to investigate and report upon the question of sewage treatment for the entire city. These investigations continued until 1907, during the latter part of which period George H. Benzenberg and Rudolph Hering were associated with Mr. Kuichling and concurred in the report submitted by him early in that year. The system of disposal now under construction follows substantially the one recommended.

Plans were submitted to the State Department of Health for approval in 1910. Realizing the importance of the questions involved, not only to Rochester but to other municipalities near the Great Lakes, the Commissioner of Health held a public hearing upon the matter and before giving his approval submitted the plans to three of the leading sanitary engineers in this country, Allen Hazen, X. H. Goodnough and F. Herbert Snow. These men and Theodore Horton, consulting engineer to the Department of Health, all reported favorably upon the general principles, but recommended some modification of the details. As there was still some local criticism of the treatment proposed and the discharge of the effluent into the lake, Prof. George C. Whipple of Harvard University was retained in 1912 to investigate and report upon the project, more particularly as to the effect upon the quality of the lake water along the shore. Professor Whipple found that the sanitary quality of the water along the beaches would not be impaired.



SIX DETRITUS TANKS (IN FOREGROUND) ARE TO BE EQUIPPED WITH MECHANICALLY OPERATED BUCKET DREDGES FOR CLEANING—AT THE OUTLET END REVOLVING SCREENS WILL BE INSTALLED—CONCRETING PLANT FOR IMHOFF TANKS SHOWN IN BACKGROUND

ESTIMATE OF FUTURE POPULATION

The designs for the intercepting sewer and treatment plant have been based upon an estimated future population in each of the eight districts served by the principal outlet sewers, the estimates varying from 24 persons to the acre in the outlying districts, to 57 to the acre in sections nearer the center of the city. These districts have a total area of 13,100 acres and the future population is estimated at 390,000. This territory tributary to the existing outlet sewers includes all the area within the present boundaries of the city, except a small section in the northeastern part of the city which has a separate system of sewers and is treated independently, as described in the Engineering Record of May 29, 1915, page 679. This estimate of 390,000 does not represent the future population of the city itself, as it includes about 2600 acres to the west of the present limits tributary to the West Side trunk sewer, and about 500 acres to the east and north of the city tributary to the East Side trunk sewer and the Lake Avenue sewer. There are also large territories to the south and east which may in time be annexed to the city.

In addition, provision has been made for the sewage of a large territory north of the city, which is not now sewered, but where the natural drainage is toward the Genesee River. This section will include an area on the west side of the river of about 500 acres, with an estimated future population of 15,000 and about 1750 acres on the east side of the river with an estimated future population of 35,000. This will make approximately 440,000 people living within the district served by the sewage disposal system as at present planned. The present population of Rochester is about 250,000.

QUANTITY OF SEWAGE

For data on which to base the size of the intercepting sewer, and to make an estimate of the quantity of sewage at the treatment plant for present conditions, gagings with Cippoletti weirs were made in 1910 of the dry weather flow in each of the existing outlets. The mean daily flow for all of the sewers was found to be 91 gal. per capita, varying greatly for the different districts from 59 to 156 gal. per capita.

The intercepting sewer is designed to provide for a future dry weather flow of 120 gal. per capita, and a future storm-water flow of 420 gal. per capita, the latter being made up of 1 part of sewage and 2½ additional parts of storm water. This basis of estimate has been adopted for all sewers of the combined system, which is the condition in all the territory now tributary to the existing outlet sewers. In the territory north of the city, where the separate system will be used, it is planned to provide for the sewage only, and a future flow of 175 gal. per capita has been assumed here. On these bases the total estimated volume of the future dry-weather flow will be approximately 55,500,000 gal. and the storm-water flow will be 173,000,000 gal. daily.

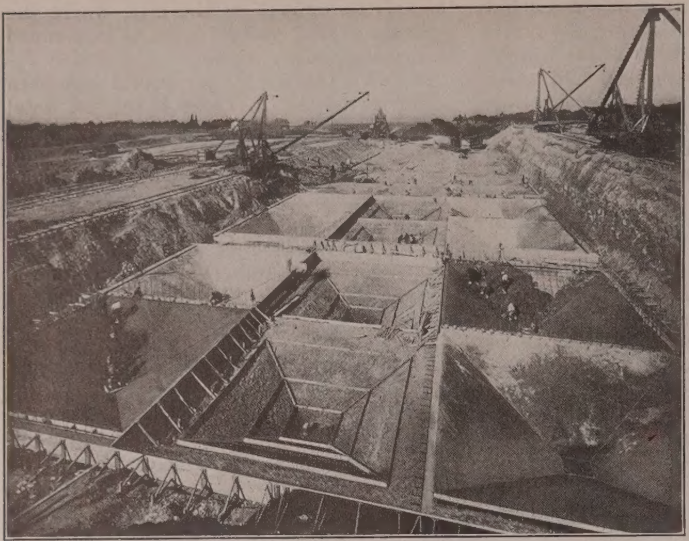
The same quantities have been used for the design of the treatment plant, but only part of the Imhoff tanks, enough for present conditions, are constructed now.

INTERCEPTING SEWER

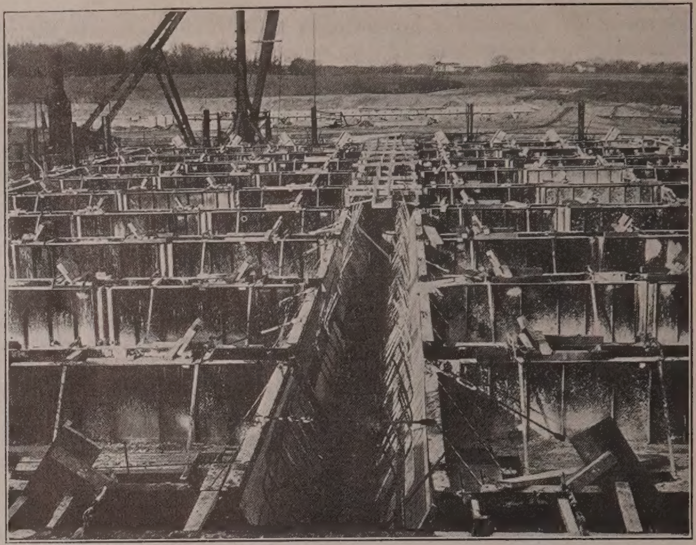
To divert the sewage from the river and deliver it at the treatment plant an intercepting sewer has been constructed to collect all of the sewage and 2½ additional equal volumes in time of storm. The storm water in the outlet sewer in excess of this quantity will pass on and discharge into the river, the existing sewers thus becoming overflows beyond the point of interception. The flow to be diverted into the interceptor will be controlled by regulating devices that will automatically maintain the required volume of discharge. These regulating devices are placed in a chamber, located, in most cases, over the intercepting sewer, and consist of a cast-iron float that operates a shutter over the inlet to the chamber. The flow will be diverted by a dam in the main sewer into the chamber, from which it will be discharged, at a lower level, into the interceptor.

The outlet for the discharge of the effluent from the plant is a steel pipe, 66 in. in diameter, made of plates ½ in. in thickness. The pipe terminates in a timber crib located 7000 ft. from the shore, discharging at a point where the water is 50 ft. deep. The methods employed in laying this pipe and the detail of the submarine joint used are described in the Engineering Record of July 3, 1915, page 20.

The location of the treatment plant is



CONTRACTOR'S TRAVELING DERRICK PLANT PLACING CONCRETE IN THE HOPPER-SHAPED BOTTOMS OF THE IMHOFF TANKS



STEEL FORMS FOR TRANSVERSE WALLS AND REINFORCEMENT IN MIDDLE WALL BETWEEN TWO TANKS

about 2 miles east of the Genessee River and about ½ mile south of the lake shore. The city has purchased 290 acres on which to build the works and dispose of the sludge.

Six Detritus Tanks

As all of the sewers tributary to the plant are on the combined system, ample provision has been made in the design for the removal of grit and floating matter by passing the sewage through detritus tanks and screens before entering the Imhoff tanks. There are six detritus tanks placed side by side, the flow being controlled by gates at the entrance to each tank. The settling chamber in a tank is 90 ft. long, 10 ft. wide and has an effective depth of 3 ft., giving a capacity for the accumulation of grit of about 100 cu. yd.

It is planned to operate the tanks so that the present dry weather flow will pass through one tank; as the flow increases in time of storm additional tanks will be put in operation, keeping approximately the same volume passing through each tank. As the water level will rise with the increased flow, the velocities will vary from 8 to 15 in. per second, the slower velocity prevailing during times of storm, since more grit is transported in the sewage.

Coarse racks with 2-in. openings are placed in the channel at the entrance to the tanks, and drainage is provided for by a system of underdrains, which, being controlled by valves, operate only during periods of cleaning.

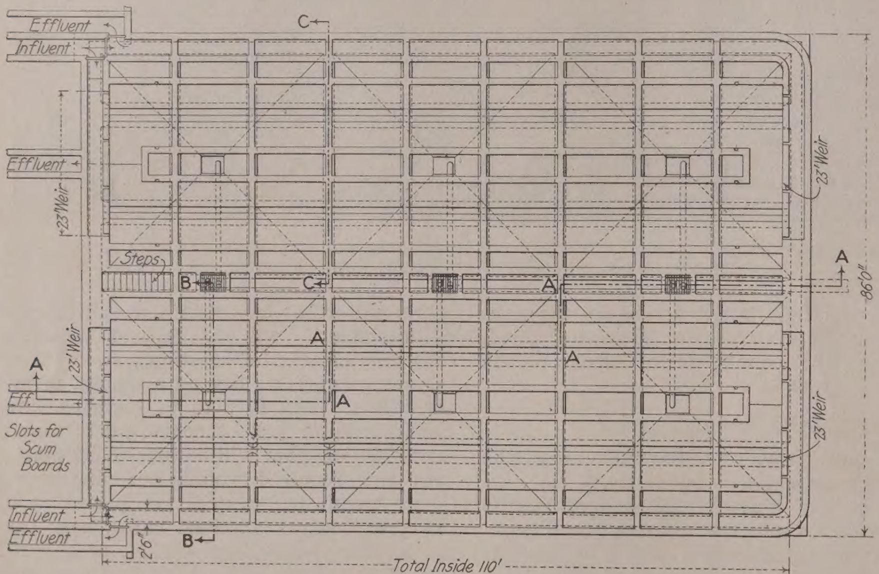
The tanks will be mechanically cleaned by an excavating machine, similar in operation to a bucket dredge. This machine will have three lines of buckets to elevate the material, which will be discharged on a belt conveyor delivering to dump cars. It will move longitudinally with the tanks on tracks placed on the walls and can be shifted under its own power on transfer tracks to any of the tanks. The excavated material placed in the dump cars will be transported by locomotives and deposited upon the adjacent city property.

Mechanically cleaned, revolving screens, of the Riensch-Wurl pattern, with ¼-in. openings, will be placed at the outlet of each of the tanks. It is not intended to accomplish by these screens what is known as fine screening, but they are used only to remove floating matter from the sewage.

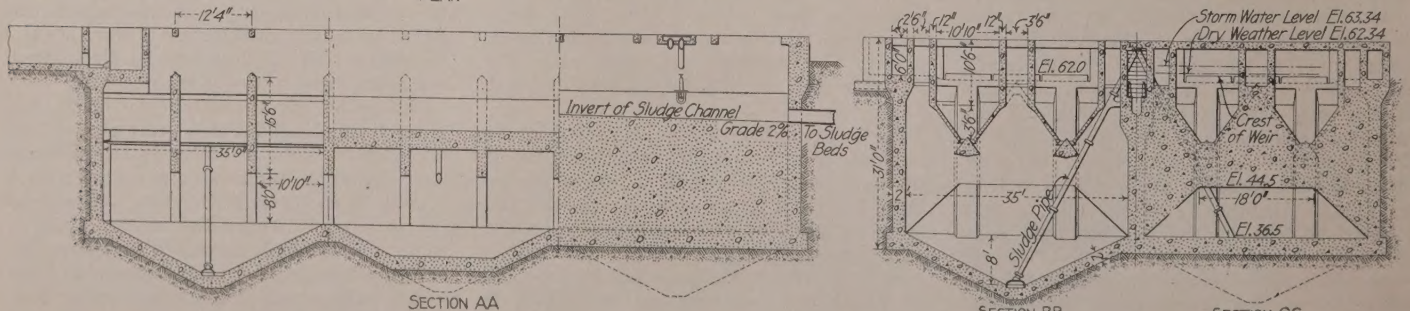
Automatic Control of Flow

From the detritus tanks the flow will pass to two main influent channels for distribution to the Imhoff tanks. These are arranged symmetrically, ten tanks being placed on each side of the influent channels. At present only the ten on the west side will be built; those on the east side are planned to provide for future enlargement as the population of the city increases.

The two influent channels run the entire length of the plant, or about 485 ft. They have a level bottom and are 7 ft. wide opposite the first tank, decreasing in width, as each successive tank is passed, to a minimum width of 2 ft. opposite the last tank. This decrease in width is designed



PLAN



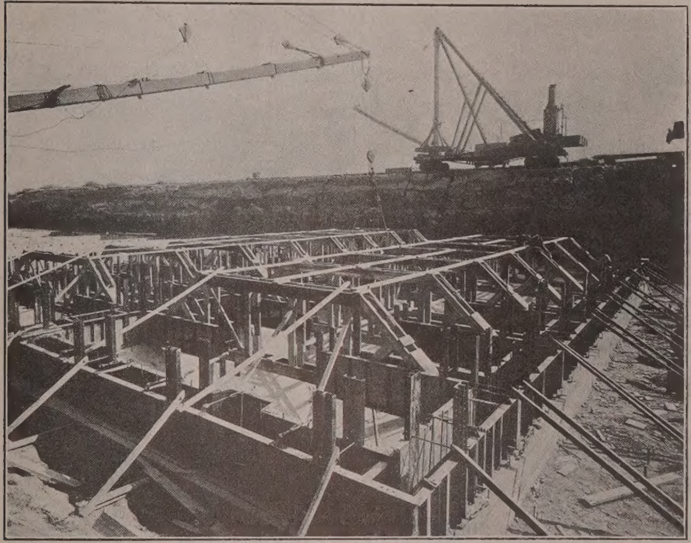
SECTION AA

SECTION BB

SECTION CC

IN ROCHESTER'S CASE RECTANGULAR IMHOFF TANKS WERE CHEAPER THAN CIRCULAR, ACCORDING TO ESTIMATES—SIDE WALLS ARE VERTICAL INSTEAD OF INCLINED—LARGE SLUDGE STORAGE CAPACITY PROVIDED so as to maintain a minimum velocity of 2 ft. per second in these channels. The desired flow for each tank will be diverted from these channels through an opening controlled by a gate. This gate will work automatically, being operated by a float in a chamber connected with the influent channel. As the water surface in the channel rises the gate will be opened, allowing an increased flow to enter each tank equal to the total increase in volume in the channel divided by the number of tanks in operation.

This regulating apparatus consists of an arm or walking-beam attached to the float with a counterweight on the other end. The gate is suspended from the arm on the same side of the pivot as the float. The ratio of the distances of the points of support from the pivot determines the relative movement of the float and gate. This ratio varies for the different tanks, being 1 to 6 opposite the first and 1 to 4 opposite the last tank. All parts of the apparatus have been made so that they can be easily adjusted to fit the varying conditions that will arise in the operation different from the theoretical assumptions.

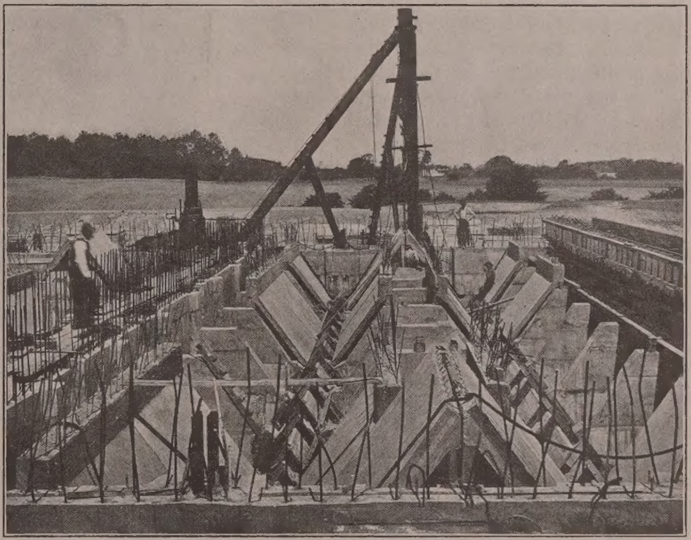


←

TRUSSES FOR FORMING ARCHES IN TRANSVERSE WALLS

→

PLACING SLABS IN BOTTOM OF FLOWING CHANNEL



The plans of the disposal plant approved by the State Department of Health in 1910 provided for plain sedimentation tanks 150 ft. long, 25 ft. wide and 12 ft. deep. This was about the time Dr. Karl Imhoff introduced in this country the type of tank bearing his name. In order to take advantage of any improvements in this line, the starting of construction work upon the plant was delayed until this proposed method of tank treatment could be examined. After extensive study and investigation it was decided to adopt the Imhoff tank in place of the sedimentation tanks first proposed. The main consideration entering into this decision was the question of the handling and disposal of the sludge. While the first cost would be considerably more, the inoffensive character and greatly reduced volume of sludge from the Imhoff tanks and the readiness with which the dried sludge could be handled, would more than offset the increased cost in reduced operating charges.

RECTANGULAR TANKS CHEAPEST

Another question requiring careful study was whether cylindrical or rectangular tanks would be the most economical. After preparing plans and estimates on both these designs and taking into consideration local conditions, it was found that the rectangular tanks were the cheaper. While the quantities in the cylindrical tank were less, the unit costs, due to the irregularities of the curved surfaces, would be very much greater. The cylindrical tank also would require more steel reinforcement than the rectangular.

In designing the tanks local conditions not common to other localities influenced the selection of a type of tank different in many features from other Imhoff tanks. In the first place the topography of the site and the character of the soil was such that it seemed best to excavate for all the tanks together by some cheap method of excavation, rather than the more costly method of excavating a pit for each tank as is done in most cases. The ground water being below the elevation of the foundation, all the excavation was dry. This made it advisable to construct the tanks with vertical side walls, avoiding the inclined surfaces that have been used to enlarge the tanks above the sludge compartment. Other controlling conditions were the shorter period of sedimentation required, as compared with other places, and the larger sludge-storage capacity adopted. These two conditions made the relative sizes of the flowing-through section and the sludge-digestion section unusual, and permitted carrying the outside walls up vertical as desired, and also allowed a greater area for the escape of gas, a feature that was also desired.

A tank is designed to handle the sewage from 21,500 persons. This will give a dry-weather flow of four cubic feet per second, and a storm flow of 14 cu. ft. per second in each tank, the storm flow passing through the same tanks as the dry weather flow, raising the water surface slightly and increasing the velocity. For these flows the velocities in the flowing-through chamber will be 0.023 ft. per second and 0.072 ft. per second, and the period of sedimentation will be 78 and 25 min., respectively. This comparatively short period of sedimentation is deemed sufficient as the final disposition of the effluent in the lake provides in itself adequate means of further treatment.

The sludge-digestion compartments are designed to provide for a storage period of 150 days, this being the probable maximum duration of cold weather during which the sludge cannot be removed.

The estimated quantity of sludge for this period is taken at 2 cu. ft. per person, making the required capacity of one tank 43,000 cu. ft. In fact, more space is provided for sludge than these figures indicate, as the three hopper bottoms are not included and the upper limit of the computed volume is taken three feet below the slot at the bottom of the sedimentation chamber.

IMHOFF TANK DETAILS

The inside dimensions of each tank are 110 ft. long, 35 ft. wide and a maximum depth of 40 ft. The flowing-through or settling compartment is made up of two longitudinal V-shaped troughs each 10 ft. wide and 12 ft. deep from the water surface to the 6-in. slot at bottom. The bottoms of these troughs are inclined slabs 5 in. thick, sloped at an angle of 1 horizontal to 1⅜ vertical. Between the troughs is a gas vent 3½ ft. wide and outside the troughs are two other gas vents each 2½ ft. wide, running the entire length of the tank, making the space for the escape of gas about 30 per cent of the total exposed water surface. The sludge-digestion compartment has three hopper-shaped bottoms, each 35 ft. square at the top and 8 ft. deep, and the distance from the hopper bottoms to the 6-in. slot in the bottom of the settling troughs is 15 ft.

The tanks are arranged so that two tanks are built as one unit, using a middle longitudinal wall to divide the two tanks and also to carry the sludge channel. Between the units is a space 10 ft. wide to be used for a driveway. The outside dimensions of one unit are approximately 116 x 79 ft. The outside walls are 2 ft. in thickness and are designed to resist an outside earth pressure from backfill to the top of the wall with the tank empty and an inside water pressure, with a maximum head of 27 ft., with no backfill. The walls are divided longitudinally into panels with a transverse wall across the entire unit every 12 ft. 4 in. These transverse walls are 18 in. in thickness and act as beams supporting the settling troughs, also as buttresses for the earth pressure and ties for the water pressure. They are arched on the bottom to permit the free circulation of sludge between the hopper bottoms. In the side walls opposite each transverse wall are placed two 10-in. channels 24 ft. long, acting as pilasters, which are in turn connected with six 1¾-in. tie rods running through the transverse walls, thereby tying the sidewalls together. The end walls are similarly constructed with tie rods running through the triangular section which forms the key to the settling troughs. The horizontal reinforcement in the panels between the pilasters consists of ¾-in. bars spaced with increasing centers as they approach the top of the wall. The middle longitudinal wall between the two tanks is 30 in. in thickness and reinforced to resist a full head of water on either side with the other tank empty.

Effluent Runs Power Plant

In order to provide for a reversal of flow through the tanks, to equalize the deposit of sludge in the hopper bottoms, both ends of the tank are identical in design, with a channel running on top of the outside wall which alternately acts as an influent, or effluent channel as the flow is reversed. The direction of flow in the tanks will be controlled by hand-operated gates.

The flow from the Imhoff tanks passes to the main effluent channel, which runs parallel to the main influent channel, but at a lower level. Up to this point the channels and weirs of all the tanks are at the same elevation. The main effluent channel is divided into two smaller channels by a partition wall which acts as a weir. The flow drops into the smaller of these channels, which is designed to carry the normal dry-weather flow; if it exceeds this amount, it overflows into the larger channel. These channels have a grade and increase in width toward the outlet, being 2 ft. and 4 ft. wide, respectively, opposite the first tanks, and 3 ft. and 6 ft. wide opposite the last tank. The dry weather flow discharges into a 48-in. pipe leading to the power plant, and the storm flow directly into the outlet pipe to the lake.

The power plant is located some distance north of the Imhoff tanks, at an elevation that will give a head capable of producing 150 h.p. with a volume equal to the dry weather flow. The 48-in. pipe from the effluent channels acts as a penstock discharging through two turbines, each acting upon the unit principle. Each turbine is direct connected with the generators and the resulting power will be used to light and operate the plant.

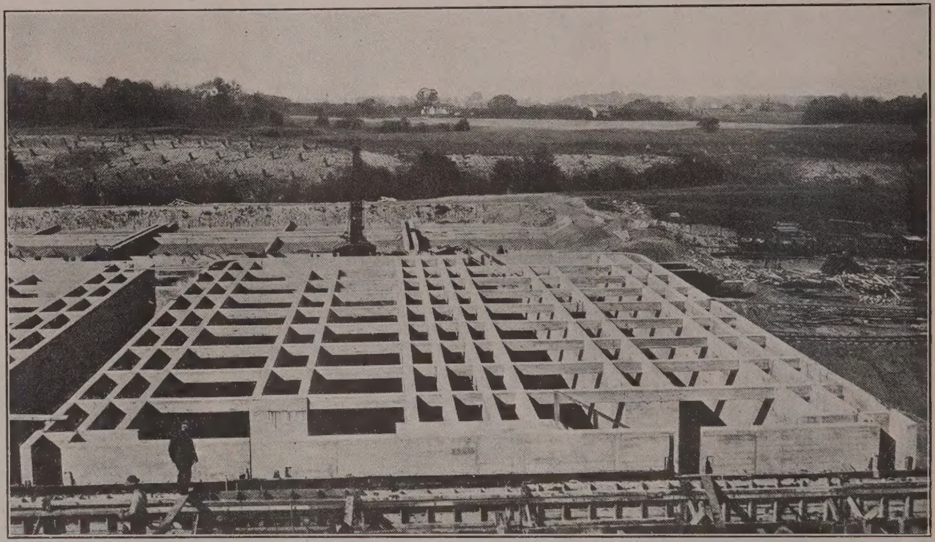
Sludge-Drying Beds

The sludge is drawn from the Imhoff tanks through 8-in. cast-iron pipes which discharge into the channel between two tanks about 5 ft. lower than the water surface in the tanks. This channel conveys the sludge to the drying beds, located directly west of the tanks. The sludge beds are designed so as to provide 1 sq. ft. of area for every three persons of the population; the area for one tank therefore will be 7166 sq. ft. and the total area for ten tanks a little over 1½ acres. The beds are divided into sections about 43 ft. square by concrete partition walls and are lined with 19 in. of filtering material, made up of 2 in. of fine sand, 3 in. of coarse sand, 8 in. of coarse sand and gravel and 6 in. of broken stone. They are underdrained with 3-in. tile, spaced 8 ft. apart. Running lengthwise with the plant are two depressed channels which serve for the collection of the drainage from the 3-in. tile and also contain tracks on which the dried sludge will be removed in dump cars. For loading these dump cars conveying machines will be installed which will carry buckets from the beds to the cars.

The final disposition of the sludge will be in deep gulleys and low places on the city property adjacent to the plant, where it will be used as filling.

Construction Work

Construction work upon the sewage-treatment system was started in April, 1911. The intercepting sewer with its connections, the conduit from the city to the plant and the outlet pipe in the lake were completed early in 1915. Work upon the plant was started in June, 1914, and on Jan. 1, 1916, all the work was completed except the installation of the equipment for operating the plant and the construction of the power plant.



THE TANKS ARE ARRANGED SO THAT TWO ARE BUILT AS ONE UNIT, USING A MIDDLE LONGITUDINAL WALL TO DIVIDE THE TWO TANKS AND ALSO TO CARRY THE SLUDGE

The principal items in the contract for the construction of the plant were 110,000 cu. yd. of excavation, 25,000 cu. yd. of concrete and 750 tons of steel reinforcement. The total amount of the contract was $333,855. This did not include the power plant buildings or any of the operating equipment.

Most of the excavation work was done with the steam shovel. The hopper bottoms of the tanks were dug with a clamshell bucket, except the final grading and trimming of the slopes, which was by hand. Standard gage equipment was used by the contractor throughout the work and all supplies and material were delivered on the site in carload lots.

The accompanying photographs show the methods used for handling the concrete in the ten Imhoff tanks. From a central mixing plant, located about 500 ft. north of the tanks, the concrete was delivered in buckets on cars to either side of the tanks, where four traveling derricks with 80-ft. booms conveyed it to the place to be deposited. These four derricks covered the entire area of the ten tanks. The concrete in the hopper-shaped bottoms of all the tanks was placed first, then the side walls of two of the units were started. Forms for two units were provided so the concrete work could alternate between these units. The side walls were carried up in courses of about 3 ft. in a lift. The specifications provided that there should be no vertical joints in a unit, the outside walls, middle wall and transverse walls being carried up simultaneously. In a 3-ft. lift on one unit there are about 200 yd. of concrete which was run continuously and so distributed that it forms a monolithic section. By this method of construction the only joints are the horizontal ones between the 3-ft. courses, or a day's work. To prevent leakages at these joints horizontal keyways were placed in the tops of all sections and great care was taken to clean thoroughly the surface and remove all laitance before starting the next course. As an additional precaution against percolation and leakage it was deemed advisable to waterproof the entire structure. This was done by the integral method, 6 lb. of waterproofing being incorporated in every yard of concrete.

Where the construction was uniform Blaw steel forms 3 ft. 4 in. in height were used on all the tanks. On the upper 10 ft., where the surfaces were irregular, wooden forms were used. The steel forms were made in panels, bolted together, and were raised and placed in position for the next lift by the derricks. No bracing was required, the forms being held up by bolts through the panels resting upon the last section, and were held in alignment by turnbuckles on top of the forms.

The plant was designed under the supervision of E. A. Fisher, consulting city engineer, with the late Emil Kuichling as consulting engineer. Myers & McWilliams, of Rochester, N. Y., are the contractors, and the work is being done under the supervision of the writer acting for the city engineer's department.

Grades in City Streets in excess of 3 per cent are not desirable for the general use of horse-drawn vehicles, according to M. M. O'Shaughnessy, city engineer of San Francisco. He pointed out that 10 per cent is the maximum desirable for trolley service and stated that the San Francisco practice is to limit asphalt pavements to grades less than 8 per cent. Where asphalt pavement is desired on grades exceeding 8 per cent the center of the street is paved with basalt block for the heavier traffic.

Few Well Equipped Ports Held to Be Preferable to Many Poorly Equipped

Fairfax Harrison of Southern Railway Would Have Ports Provide Water Terminals and Collect Charges from Traffic Instead of from Railroads

PUBLIC ownership of and responsibility for interchange facilities between rail and water traffic at seaports have been advocated in recent years by a number of students of transportation. Less familiar is the doctrine that there should be a few well equipped ports rather than a large number with poor facilities. Both ideas were presented by Fairfax Harrison, president of the Southern Railway, at the third national foreign trade convention, held in New Orleans recently. Mr. Harrison contended not merely that it was uneconomical for each of several railroads to build and maintain separate water terminals at one port, or for one railroad to build and maintain separate water terminals at several ports, but that the traffic itself, and not the railroad, should pay the terminal charges. He held that the transshipment should be regarded as a separate element of the traffic movement, just as the water transportation is, and that inland transportation alone is the function of the railroad. To his mind, unless the ports are ready to provide the necessary terminal facilities they should attempt to rely on natural rights to traffic.

Extracts from Mr. Harrison's address follow:

TOO MANY TERMINALS

Generally speaking, in this country facilities at the ports for the interchange of export and import traffic have been provided by the railroads themselves. In numerous cases several railroads serving a single port have each provided independent waterfront terminals, and railroads serving more than one port have provided separate facilities for each port served, thus involving large investments of capital for which there has been no adequate return, because competition has to a considerable extent required the absorption of terminal costs as a practical deduction from the normal inland transportation charges, and, further, because the business is divided between too many ports and between too many separately owned and operated terminals.

Such conditions are economically unsound and must come to an end if economy of transportation is, in a national sense, to be a factor in the increase of the volume of our export and import traffic. A large number of insufficiently equipped ports is not as efficient a factor in the development of commerce at the stage we have now reached as would be a few sectionally representative ports, thoroughly well equipped. If this view shall obtain there is in prospect an increasingly fierce competition between individual ports for this position of sectional representation. On past experience we may expect the railroads to be in the vortex of this controversy. It may be settled by the biological law of the survival of the fittest, or it may be settled by the modern panacea for business ills, a statute; but in any event the best interests of our foreign trade will be in abeyance until it is settled. The nation which has in recent years made the largest deliberate increase of its foreign commerce has concentrated on two well equipped ports. It is probable that in this respect Germany's transportation costs must have been benefited from the operation of the economic law that concentration of volume, short of congestion, reduces cost units.

PAST DEVELOPMENT OF OUR PORTS

The development of the seaports of the United States, and especially that of the South Atlantic and Gulf ports, in relation to the railroads, has had its own peculiar history. To-day, when in the matter of rail transportation the political theory of "equal opportunity for all, special privileges to none" is having what is perhaps a too literal application, because it is often in the teeth of the natural laws of trade, the rational explanation of the partial and incomplete development of some of our seaports is forgotten and the attempt is made to explain it by diabolical design.

When the first railroads were built from the sea to the interior, they were comparatively small and always weak units. At the beginning they were economic monopolies and controlled all the traffic of a territory, insufficient though that may have been. As the railroad system was linked up and competition began between ports and between rival producing territories, the management of each local line which reached a port, actuated by the usual resource of the weak in dealing with a strong and impetuous force such as moves competitive commerce, exercised every effort of ingenuity to discriminate in transportation practices and charges in favor of its single port.

CHANGED CONDITIONS

When it came to pass that rail transportation swallowed all other forms of inland transportation, and the shipper, whatever his location, no longer depended upon any single railroad or any single seaport, the franchises of particular ports in respect of certain traffic were thus transmuted into competitive opportunities. It followed that discrimination in favor of the individual port has gradually been withdrawn by the railroad, not from any change of heart nor even from any lack of good will, but as a consequence of economic pressure. This consequence of the development of transportation in a national sense seems to have proved an apparent atrophy to the commercial enterprise of some of the seaboard communities affected. They had come to depend altogether upon the railroad for their commercial pabulum: they had looked to the railroad to supply not only the transportation and the terminals, but the traffic as well, and when in time the discrimination in their favor was removed, partly by the working of an economic law and partly by the fixed and inelastic methods which have, in the past, been nationally characteristic of our public regulation of railroad practices, it has resulted that some seaport communities have exercised more energy in asserting claims to assumed natural rights and in prosecuting charges that the railroad has discriminated against them, with evil intent, than in adjusting, as the railroads have done, their practice to new economic conditions.

PORTS SHOULD PROVIDE FACILITIES

Export commerce will always seek the line of least resistance. It will go to the point where the service is best, where storage facilities are most readily accessible, and most of all where there are ships. To bring the ships the successful port seeks above all to develop its import traffic and its banking facilities. Next in importance, the port itself should provide terminal facilities for the exchange of tonnage between rail and water carriers. My own view is that the demands on the railroads in the future in respect of inland transportation are going to be at least equal to the rates which the public will allow for rail service, and that the seaport must hereafter look elsewhere than to the railroads to provide, or even to pay for the use of, water terminals.

Seaport communities desiring to participate in the benefits of foreign commerce and to obtain a competitive advantage over other available ports should then provide the necessary terminal facilities either through municipal ownership or through local terminal companies supported by local interest, and thus undertake the responsibility of supplying facilities without discrimination for all ships and all railroads reaching the port; and further, they should impose charges upon the traffic, rather than upon the railroad, sufficient to make the terminal self-supporting. In competition with rival ports they may have to bear in the form of local taxes or otherwise locally so much of the terminal cost as may be necessary to attract and hold competitive traffic which is free to seek any one of several ports. New Orleans has taken a step in this direction through its public ownership of docks and through the wise policy of the Dock Board in undertaking to have uniform charges established for service performed at the city docks and at those provided by the railroad and the railroad-owned terminal companies.

RAILROADS WOULD CO-OPERATE

When this point has been made clear as a principle of sound growth, it may be added that, while the obligations of a railroad as a common carrier are not different with respect to foreign commerce than with respect to domestic commerce, the policies of a railroad need not necessarily be limited altogether by its obligations. They never have been in the past and will not be in the future. The railroad, so long as it is a function of private endeavor, properly may and always will consider its interests as a business enterprise. Because prosperous communities along its lines bring increased traffic to the railroad, the alert management is vitally interested in the development of the territory which it serves, and in helping the producers in that territory to find profitable markets either at home or abroad. As a large proportion of the products of the United States, either as raw materials or manufactured commodities, find, or, more strictly speaking, after domestic needs have been met, ought to find, markets in foreign countries, the carriage of these products to the seaports make up such a large part of the business of the railroads that they may properly so shape their policies as to encourage this business. This many railroads have done, and perhaps, as affects their own interest, have at times overdone.

Highest Arch Highway Viaduct of Striking Appearance Economically Constructed

High-Level Bridge Over Cuyahoga River Gorge Near Akron, Ohio, Erected on Steel Arch Centers Previously Used, with Slag for Aggregate

An EXAMPLE of a satisfactory solution of the problem continually arising—how to construct with the available funds a structure of pleasing architectural appearance—is found in the design of the recently completed high-level bridge for highway traffic over the Cuyahoga River gorge near Akron, Ohio. The construction of a reinforced-concrete arch viaduct of striking appearance instead of the usual steel trestle was made possible through the utilization by the contractors of previously used steel centers, after modification of the arch outlines and span lengths; through the design of the high hollow piers without batter, allowing the continuous use of the same sectional forms, and through the use of sand from the approach cut for the fine aggregate and of blast furnace slag for the coarse aggregate.

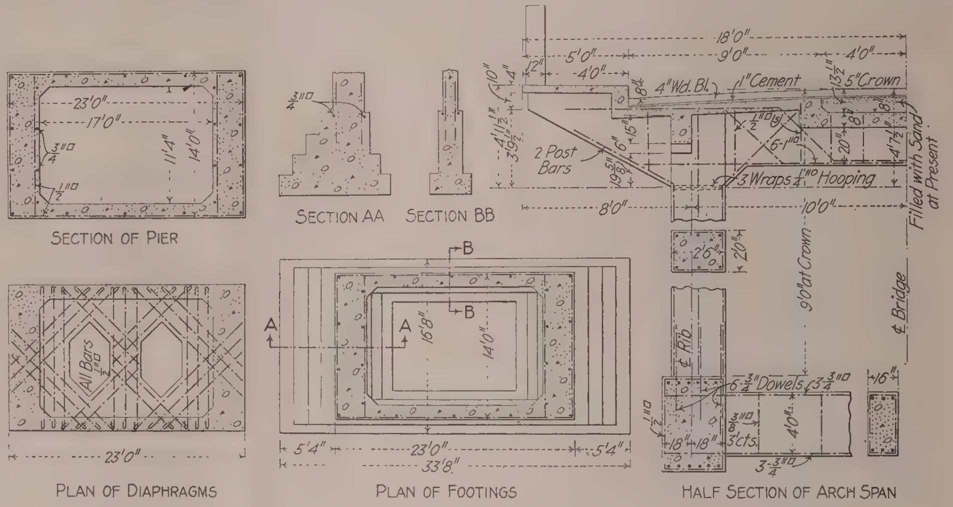
Highest Highway Structure of Its Kind

This viaduct is the highest highway structure of its kind, 190 ft. from bed of stream to level of roadway. The Fontpedrouse masonry arch viaduct in France, described in the Engineering Record of Dec. 18, 1915, page 768, is 225 ft. high, but is a two-level structure. The recently completed Tunkhannock viaduct, a railway structure, is 240 ft. high.

The excessive height of the piers in the Akron bridge made the problems of construction more difficult than usual. Special care in erection was taken to avoid excessive unbalanced thrusts on these piers. The three-hinged steel arch centers with 2-in. tie rods to take the thrust are of course the most economical for such a location, the centers being placed by the construction cables.

Desire for Ornamental Bridge at Low Cost—Preliminary Designs

The original plans called for a steel bridge at a much lower level, carrying a roadway only and requiring steep approach grades. After considerable agitation additional bonds were voted to construct a high-level bridge with sidewalks and provision for electric-railway loads. Two sets of plans were then made, one for a steel trestle and one for an arch viaduct of reinforced concrete. When the bids were opened, those on the steel structure were well within the amount appropriated, but none were received on the concrete structure within that amount.


SECTION OF PIER

SECTION AA

SECTION BB

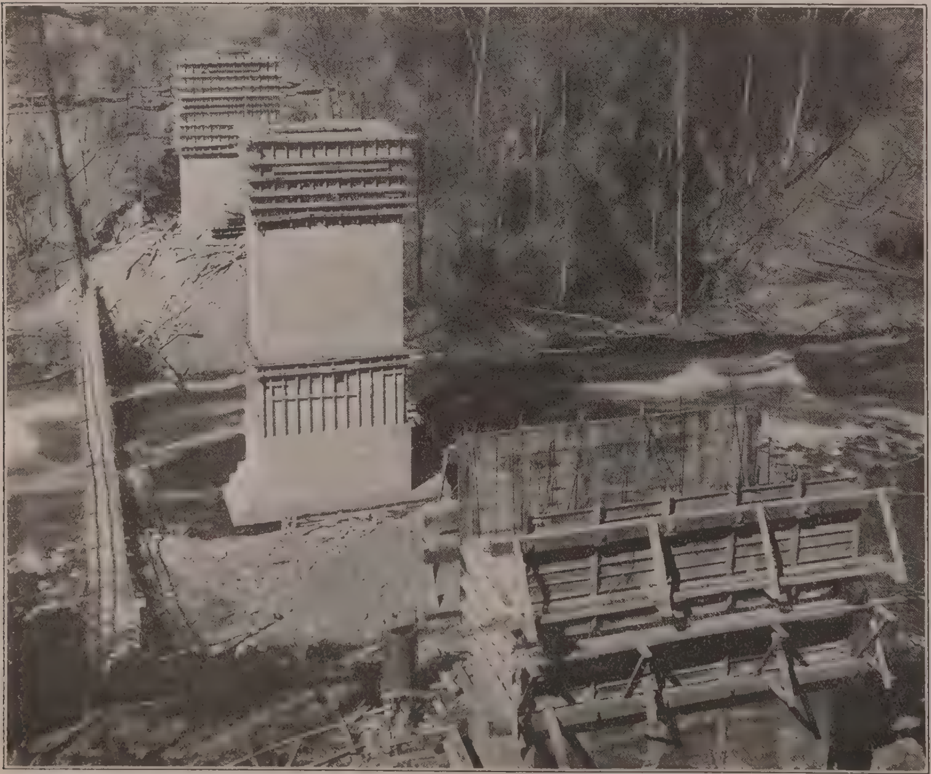
PLAN OF DIAPHRAGMS

PLAN OF FOOTINGS

HALF SECTION OF ARCH SPAN

TYPICAL SECTIONS OF ARCH SPAN AND PIERS—REINFORCEMENT OF FLOOR

All floorbeams between columns on arch spans and on approaches are spaced 9 ft. 5 in. on centers.



PROGRESS IN CONSTRUCTION OF THE HIGH PIERS SHOWS CONTINUOUS USE OF FORMS

By this time, however, the people had made up their minds that only a concrete bridge would properly conform to the site, which is owned by the city of Akron, and is to be used in the future as a park. Opposition to the letting of a contract for a steel bridge was therefore so great that the county commissioners rejected all bids. At the next letting one bid was within the available fund. This was based upon a modified design, increasing the span of the arches and making them full centered to allow the use of steel arch centers previously applied in the construction of the arch bridge at Allentown, Pa. Economy was further attained by the rectangular hollow-pier design, permitting the use of 5-ft. sectional forms, made of both wood and steel, which could be used continuously.

General Dimensions

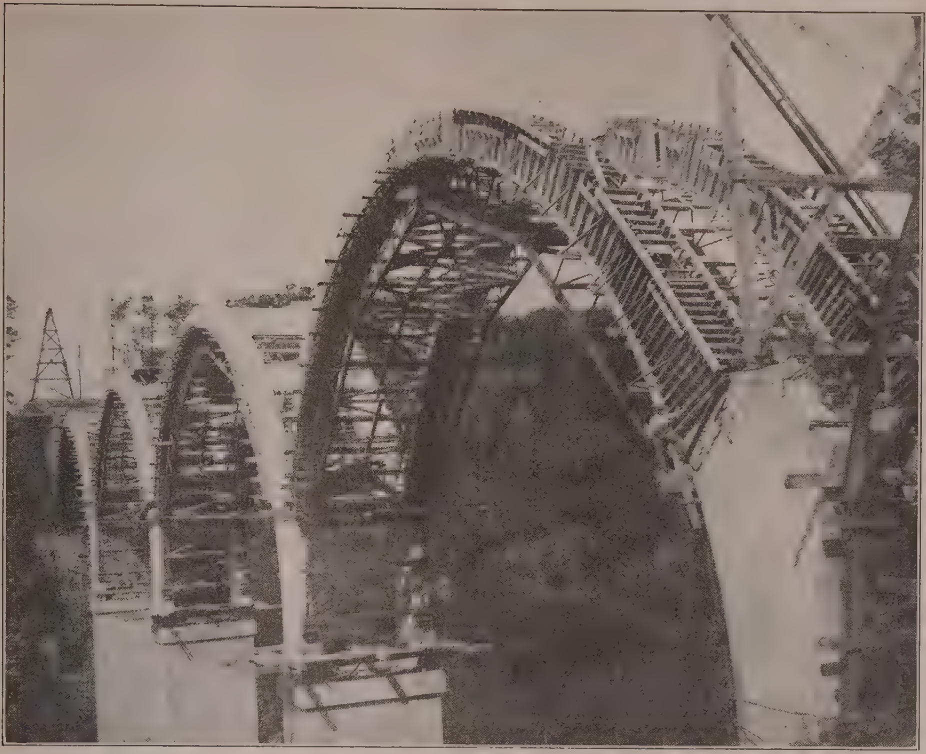
The total length of the viaduct is 781 ft. 9 in. The bridge has a 24-ft. roadway and two 4-ft. sidewalks, and provision for a single-track electric road in the future. It is located on the main road to Akron from the north, on an extension of North Howard Street, about one-half mile outside of the city line. The Cuyahoga River gorge at this point is a deep ravine with steep banks of shale and heavily wooded sides.

As finally built, the structure consists of five main arch spans 127 ft. long between centers of piers. Each arch has two main ribs, 20 ft. on centers, supporting spandrel columns. The three high piers are hollow, rectangular in section, reinforced with horizontal and vertical steel, and the walls strengthened by horizontal diaphragms about 40 ft. apart vertically. The highest pier is 110 ft. high and of the dimensions shown in the drawing.

The approaches are of exactly the same floor construction as the main-arch span, similar columns to the spandrel columns, spaced 9 ft. 5 in. on centers, being carried down to the rock foundation. On the south approach the columns, because of their great height, are braced by 12 x 12-in. longitudinal struts at about the mid-height, and transverse struts with knee braces are also used.

Live Loads and Stress Analysis

The bridge was designed for a uniform live load of 100 lb. per square foot on the roadway and 75 lb. on the sidewalks, for an



STEEL ARCH CENTERS SUPPORTING TIMBER FORMS FOR THE MAIN RIBS

18-ton truck on four wheels, 9000 lb. per wheel, 5-ft. gage and 10 ft. on centers, with 30 per cent impact, and for a 40-ton car with trucks 22 ft. on centers, wheels 10,000 lb. each, spaced 6 ft. apart, with 40 per cent impact. Wind pressure was considered at 30 lb. per square foot. The allowable unit stresses were 750 lb. per square inch compression in concrete and 16,000 tension in steel. On the foundation about 5 tons per square foot for dead load and 10 tons for the worst condition of unbalanced thrust were allowed. The maximum compression on the concrete of these piers under full live load and wind pressure is about 400 lb. per square inch.

The arch analysis was made in the usual manner, two street cars and two trucks being assumed. Stresses were computed to include the effects of a rise of temperature of 15 deg. and a fall of 60 deg., the rib-shortening effect being included as 16 deg. in the 60-deg. fall. It was found that ribs 3 x 3 ft. at the crown and 3 x 5 ft. at the springing line would carry the stresses. These sections were increased when the design was changed, so that the ribs as constructed are 4 ft. deep at the crown and 6 ft. deep at the springing line. Seven transverse struts 4 ft. deep with end knee braces connect the two main arch ribs. Each rib is reinforced with twelve ¾-in. square rods, with ½-in. square ties on 3-ft. centers.

In computing the stresses in the main ribs when the thrust line was outside of the middle third the stresses were found as for eccentrically loaded columns, including the steel in both tension and compression. When the thrust line was inside the middle third the effect of the steel was neglected. It will be noted that the percentage of steel at the crown is only 0.39 per cent. This is due to the excessive section used for the modified design.

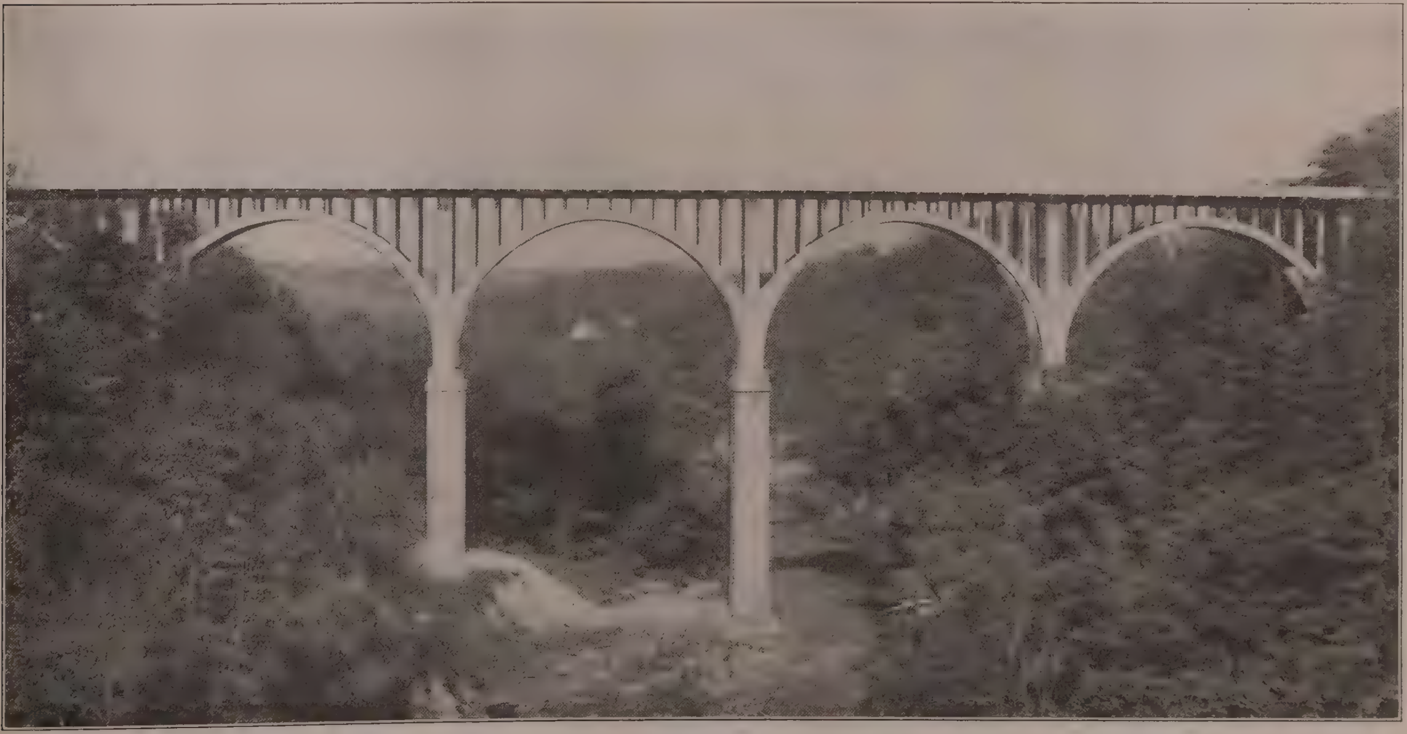
The floor slabs are of two thicknesses, 8 in. and 6 in., as seen in the half section. Two-way reinforcement is used between the transverse floorbeams and the longitudinal stringers formed at the sidewalk curb and at the side of the central depressed 8-in. slab designed to carry the future electric-railway track.

CONSTRUCTION BY CABLES AND TOWERS

About 50 ft. back from the ends of the bridge 70-ft. towers were erected and a cableway which sagged about 50 ft. under the maximum load was swung, and operated from a powerhouse at the south end. The mixing plant, located just south of the south arch abutment, consisted of a large V-bottom bin of two compartments for the aggregate, with steam pipes for heating the material in cold weather. The coarse aggregate was brought to this bin by cars on a track which was extended about 1000 ft. to the site by the contractor.

The fine aggregate was stripped from the south approach cut by a mast and boom with an orange-peel bucket suspended from the boom, and loaded into small cars which ran out over the bin and dumped into a revolving cylinder screen to carry the larger particles over into the coarse aggregate compartment. The mixer, placed below the bin, discharged into bottom-dump buckets which rode on push cars operated by a cable from the mixer engine. When full they were pulled out under the cableway, where they were picked up and delivered where needed.

In concreting the superstructure it was necessary to consider carefully the se-



SATISFACTORY GENERAL APPEARANCE OF HIGH LEVEL BRIDGE AT SITE OF FUTURE PUBLIC PARK NEAR AKRON quence of pouring, so as to avoid excessive thrust at the top of the high slender piers. This sequence was as follows: (1) All steel centers were placed before any concrete was poured in the arch rings; (2) timber forms were completed in the two north spans and the concrete was poured in the arch rings for the north span, the timber forms being thereafter kept one span in advance of the pouring; (3) the columns were poured on the north span, followed by two and a half panels of the floor at each end of the north span, care being taken to keep the loads nearly balanced at all times; (4) the columns were poured on the next span, the piers being able to take up the unbalanced thrust produced by the weight of the columns and by two and a half panels of floor; (5) two more panels were poured at each end of the two north spans, and the columns in the third span; (6) the center panels were poured in the north span, completing this arch, two more panels in each end of the second and third spans, the columns in the fourth, etc., maintaining this system for the remaining arches.

The maximum settlement of the arch ribs under this unequal loading was about one-half inch, and a corresponding rise in the adjacent arches was noted.

The location survey was made by R. S. Ferguson, by direct measurements on the slope by tape and transit, checked by angles turned from a base line located approximately at right angles to the axis of the bridge. The entire work was in charge of Wilbur J. Watson & Company, consulting engineers for Summit County, which built the bridge. Stress sheets and designs were made by A. F. Blaser and R. S. Ferguson. George L. Ehrman was resident engineer. The contractor was the MacArthur Brothers Company of New York City, and the total cost was $114,000.

Good Progress Being Made on Victoria Breakwater

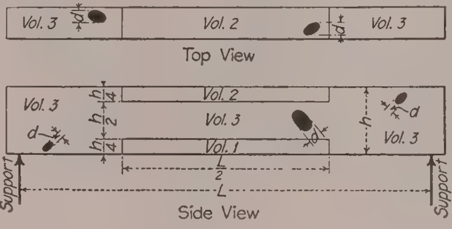
DURING 1915 work on the breakwater at Ogden Point, Victoria, B. C., has progressed so rapidly that the structure, which, at the beginning of the year, was not visible above the surface of the water is now two-thirds finished. The breakwater is composed of three arms, the first extending only 330 ft. from shore, the main arm having a total length of 1500 ft., and the outer arm which will be 700 ft. long. On Jan. 1 the work had been completed for a distance of 1630 ft. from shore. Over 1,000,000 tons of coarse and fine rubble have been used in the construction thus far, it is reported. J. S. Maclachan, Dominion government engineer, has given out the following figures referring to total quantities thus far handled on this contract: Coarse rubble dumped, 792,415 tons; core, or fine rubble dumped, 241,925 tons; granite blocks placed in position, 93,279 tons; concrete poured, 20,883 cu. yd. During 1915, 273,000 tons of rubble stone were deposited, 75,000 tons of granite blocks placed and 19,000 cu. yd. of concrete poured.

THE COST OF STREET CLEANING at Victoria, B. C., is now 13.4 cents per 1000 sq. yd. This does not include plant rental and overhead charges. All the work is done with hand brooms, pick-up carts and cans. No flushing water is used.

Forest Service Proposes Douglas Fir Grading Rule

Applies to Structural Timbers Only and Takes Account of Density as Well as Defects—Six Rings or More Per Inch Required

THE U. S. Forest Service, through the Forest Products Laboratory at Madison, Wis., has proposed a rule for grading Douglas fir timber used for structural purposes. Only one grade, No. 1, is provided for. The rule follows the recent trend in yellow pine rules, in placing in first position clauses that determine the density of the timber. In addition to the visual inspection for density—by a rings-per-inch clause—the weighing of dried borings is provided for when the sticks do not meet the rings-per-inch rule. The plan of restricting knots in beams, as developed for the yellow-pine rule, is also followed.



DIVISION OF BEAM INTO VOLUMES FOR LOCATION OF KNOTS

The rule proposed by the laboratory, with notes thereon, is as follows:

REQUIREMENTS FOR DENSITY AND RATE OF GROWTH

1. Shall contain only sound wood.

2. *Density Determinations by Borings.*—One inch holes will be bored into the end grain of the timbers with a clean cutting bit, each hole being 1¾ in. deep. All borings from a single timber shall be placed together and dried to a constant weight of 100 deg. C. They shall be weighed after being dried and without being allowed to cool and shall weigh not less than 10 grams per hole. All holes shall be bored into a representative portion of the cross-section free from checks or shakes. The holes should not be bored closer than 1 in. from the pith nor into knots or pitch streaks. The number and location of holes shall be as indicated below:

a. Beams or posts 35 sq. in. in cross-section or less. One hole will be bored into a representative portion of the cross-section.

b. Beams or posts with a cross-section of from 35 to 90 sq. in. Two holes will be bored.
- A. Beams, one in the lower quarter and one in the upper quarter, each representative of the quarter in which they are placed.
- B. Posts, one near each side or corner. opposite sides.

c. Beams and posts over 90 sq. in. cross-sectional areas. Four holes will be bored.
- A. Beams, two in the lower quarter, one in the middle half, and one in the upper quarter of the cross-section.
- B. Posts, one near each side or corner.

2a. *Density Determinations by Inspection.*—Any timbers fulfilling the following will be accepted without borings: Shall show on the cross-section an average of not less than one-third summerwood and six or more annual growth rings to the inch. The inspection for summerwood and rings shall be made on a radial line from the pith as follows:

a. When the pith is present or can be accurately located.
- A. Radial line of 5 in. present.
  - *a.* Apply inspection over third, fourth and fifth inches from the pith.
- B. Radial line of 5 in. not present.
  - *a.* Apply inspection to the second inch on 2 x 3, 2 x 4, 2 x 6, 3 x 3, 3 x 4, 4 x 4, or any other dimension material that has less than 16 sq. in. on the cross-section.
  - *b.* In larger material apply inspection to the three inches farthest from the pith.

b. When the pith is not present or can not be accurately located.
- A. When material is over 3 in. thick apply inspection to three inches nearest the pith.
- B. In dimension material 3 in. or less in thickness apply inspection to second inch from the edge nearest the pith.

c. The radial line chosen shall be representative with respect to rate of growth and percentage of summerwood. In case of disagreement between purchaser and seller the figures obtained by averaging the number of annual rings and percent of summerwood on the two chosen inspection lines shall be used.

3. It is sufficient if either end passes the inspection.

RESTRICTIONS ON KNOTS IN BEAMS

4. Shall not have in Volume 1 (see figure) sound knots with a diameter greater than 1½ in. or one-fourth the width of the face on which they appear—or knots over one-half inch in diameter which are insecurely attached to the surrounding wood. Shall not have in Volume 2 sound knots with a diameter greater than 3 in. or one-half the width of the face on which they appear—or insecurely attached knots with a diameter greater than 1½ in. or one-fourth the width of the face on which they appear.

The aggregate diameter of all knots within the center half of the length of any face shall not exceed the width of that face.

The diameter of a knot on the narrow or horizontal face of a beam is to be taken as its projection on a line perpendicular to the edge of the timber. On the wide or vertical face, the smallest dimension of a knot is to be taken as its diameter (see figure).

RESTRICTIONS ON KNOTS IN COLUMNS

5. Shall not have sound knots whose diameters are greater than 4 in. or one-third the least width of the column, or knots over one-half inch in diameter which are insecurely attached to the surrounding wood.

The diameter of a knot is to be taken as its projection on a line perpendicular to the edge of the column—as on the narrow edge of a beam (see figure).

RESTRICTIONS ON SHAKES AND CHECKS IN BEAMS

6. Ring-shakes shall not occupy, at either end of a timber, more than one-fourth the width of green material, nor more than one-third the width for seasoned material.

Any combination of checks and shakes which would reduce the strength to a greater extent than the allowable ring-shakes will not be permitted. Shakes shall not show on the faces of either green or seasoned timber.

RESTRICTION ON DIAGONAL GRAIN

7. Shall not have in Volume 1 diagonal grain with slope greater than one in twenty.

Notes on Proposed Rules

1. The greater part of Douglas fir structural timber is now sold under grade classifications adopted by associations of lumber manufacturers. These classifications differ somewhat and are described in rules published by the several associations. The rules here proposed embody the principles which should guide in the selection of high-grade structural timbers. Their use will result in securing timbers of higher average strength and greater uniformity than can be obtained by the use of any of the existing commercial rules. They are intended to apply to structural timbers only and not to material to be used where factors other than strength are of prime importance. In specifying material, the advantages connected with the use of commercial grades should be considered and the commercial grades adhered to as long as it is certain that material selected under such rules will meet the requirements.

2. The importance of shakes and checks in the middle half of the height of a beam is dependent upon the magnitude of the horizontal shearing stress. The specification given is for beams in which the allowable shearing stress is developed. In beams whose length is more than fifteen times their height, the allowable shearing stress is not usually developed, and as the ratio of length to height increases the importance of these shakes and checks decreases proportionately. Ring-shakes showing on an end should be considered as extending to the center. Checks and radial or star-shakes are not usually continuous in the direction of the length of the timber but should not be allowed if, in the judgment of the inspector, their weakening effect is greater than that of the allowable ring-shakes.

GREEN AND SEASONED MATERIAL

Allowable conditions for both green and seasoned material are given because checks are formed and shakes further developed during seasoning. The maximum amount of shakes and checks should not be allowed unless it is practically certain from the appearance of the timber, or from a knowledge of the seasoning conditions, or length of time elapsed since cutting, that it is thoroughly seasoned. For purposes of this rule, it will be considered that at least one and one-half months per inch of thickness is required for material to become thoroughly seasoned.

3. In dry interior construction a working stress of 1600 lb. per square inch may be used with beams which meet the requirements of the proposed rules.

AN 11-TON LOAD ON AN 18-PER CENT GRADE was one of the features of the transporting of a steel casting to the solar observatory on Mt. Wilson, near Pasadena, Cal. The casting, whose net weight was 8½ tons, was loaded on a motor truck and was hauled safely over the 9 1/3-mile grade in a little over six hours. The average grade for the entire distance is about 12 per cent.

Cellular Type of Quay Wall at Halifax Terminals Compared with Other Designs

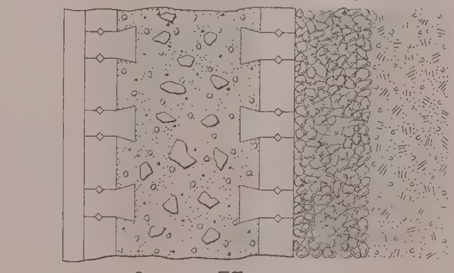
Large Precast Hollow Blocks of Reinforced Concrete Are Placed in Stacks About 50 Feet High and Compartments Filled with Rubble or Concrete

AFTER a thorough investigation of the relative costs and advantages of various types of quay walls and wharf construction, the engineers who designed the Halifax Ocean Terminals adopted a cellular type which contains many unique features. The work of European and American engineers was reviewed and all the available types were finally reduced to five. Designs and estimates of cost were made for each of these types, and their advantages and disadvantages carefully studied and compared, keeping clearly in mind the requirements for rapid and yet permanent construction, the nature of the foundation conditions, and the local aspects of the skilled labor problem.

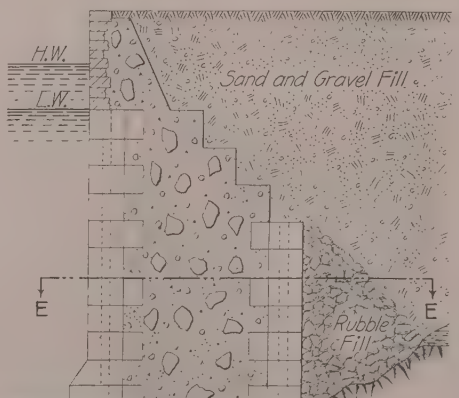
COMBINATION TYPE EVOLVED

As a result of this investigation a combination type of quay wall has been evolved. It contains many new design features and is proving to be economical and rapid in construction, because of the extensiveness of the work, the economies in the casting yard, and the effective use of mass concrete and rubble filling for the compartments. It combines the advantages of reinforced concrete with the cheaper mass concrete and eliminates most of the objectionable features of the other designs studied.

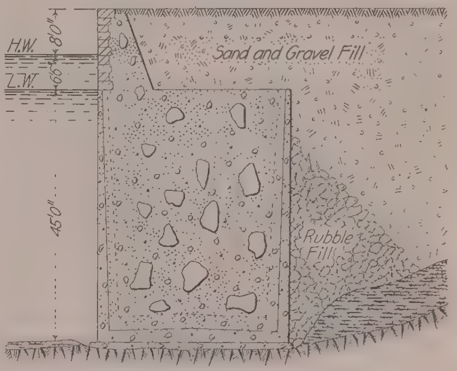
As explained in the previous articles in the Engineering Record of Jan. 22, page 102, and Jan. 29, page 143, the adopted design E consists of stacks of cellular reinforced-concrete shells, or blocks, securely bonded and bedded by mass concrete and grout, cast on shore and placed in position by economical methods already described. Thus the concrete shells are thoroughly cured before coming in contact with sea water and the mass concrete is deposited under ideal conditions in quiet water and in permanent forms. The adopted design provides for the effects of settlement and temperature changes by the vertical joints and short sections separated by rubble filling. It provides for unforeseen difficulties by possible alterations in the filling of the different compartments. It is most effective in its adaptability to the varying depths to rock bottom and in the elimination of expensive site-preparing operations.



SECTION EE



DESIGN A—CONCRETE BLOCKWORK WITH MASS CONCRETE HEART



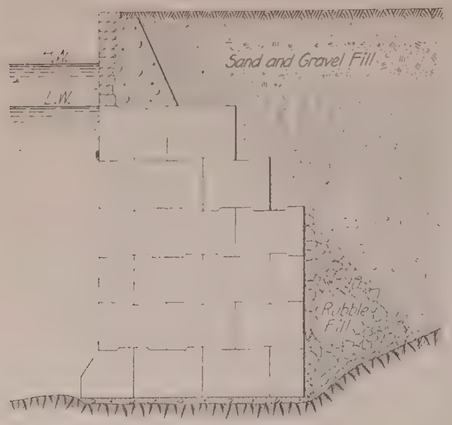
DESIGN B—REINFORCED-CONCRETE CAISSON FLOATED TO POSITION

The following detailed comparison of the five available designs, including the reasons for the adoption of the type used, a general statement of the theoretical analysis based upon given assumptions and a description of the design of the reinforced-concrete shells or blocks, is taken largely from a report to the Hon. Frank Cochrane, Minister of Railways and Canals, made by F. W. Cowie, consulting engineer, Montreal, Can.

DESIGNS CONSIDERED

Some of the determining conditions imposed by the site and the requirements of the problem were: The specified 45-ft. depth below low water, the entire elimination of timber except for fenders or where not exposed to sea water, the impossibility of the use of piles of either timber or reinforced concrete owing to the solid rock encountered, and the desire for rapidity of construction. Design A, a typical concrete blockwork wall with a mass concrete heart, would require the bottom of the harbor to be leveled carefully because of the increase in irregularity at the top courses resulting from uneven bedding of the bottom courses. To insure rapidity of construction elaborate temporary staging would be required, which would be expensive, as pile staging could not be used and the initial cost and cost of maintenance would be high, due to the exposed location.

Design B, a series of reinforced-concrete caissons 110 ft. long, filled with concrete, to be built in a floating dock, upon scows, or partly on launching ways and then launched and completed in the water, would present many difficulties. The great weight and draft of the caissons would require a heavy floating plant with tugs to assist in launching and placing in position. Winter construction would be impracticable. The preparation of the bottom would be a



DESIGN C—SOLID BLOCK WALL

serious expense, as in many places it would be necessary to dredge solid rock to depths up to 20 ft. The bed would be leveled by mass concrete or concrete in bags and would thus form a horizontal plane of weakness on which sliding might take place.

Design C, of precast solid blocks weighing 30 to 50 tons each, would require the use of heavy floating cranes or cranes on temporary staging and have the same objections as the first two in the preparation of the bottom and the loss of time in winter. The advantage of this design lies in the fact that no concrete is deposited under water until it is thoroughly cured.

REINFORCED-CONCRETE DECK

Design D is a reinforced-concrete deck of beam and slab type supported upon concrete piers or cylinders spaced about 22 ft. apart longitudinally. Transversely the spacing would be about 30 ft., to suit the shed columns. Great difficulty in this type would be encountered in places in preparing the bottom and setting the cylinders in a vertical position. Until the decking and bracing could be completed these cylinders would be in danger of injury from the floating plant or from ships. The rate of construction would be slow. The initial cost was estimated to be the same as the more solid type E adopted. The danger of serious consequences in case of accident and the difficulty in repairing this open type were strong considerations against it.

The adopted design E consists of vertical stacks of cellular reinforced-concrete shells or hollow blocks 22 ft. long, 31 ft. wide and about 4 ft. high, placed one directly above the other, and securely bonded and bedded by mass concrete deposited in the front and middle compartments and by grout in the 10-in. grout holes. All the bottom shells and half the height of the next shells above will be filled with concrete to form a solid full-width foundation and ballast floor.

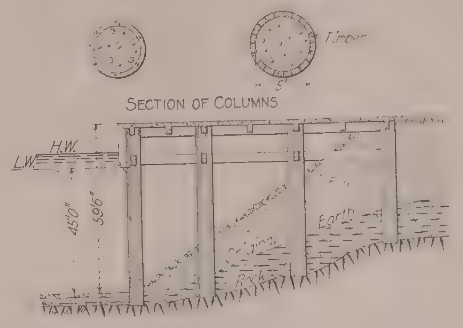
GUIDE POSTS FACILITATE SETTING

Each stack is keyed to the adjoining section by vertical reinforced-concrete guide posts of square section fitting into V-shaped recesses in the blocks. These posts facilitate the setting of the blocks under water, restrain lateral movement in case of settlement, and prevent the escape of the filling in and behind the wall. The spaces between the stacks of shells are filled with rubble or other filling, thus forming an expansion joint and allowing each stack to settle independently without affecting adjoining sections.

The estimated costs of the above-described five designs, including mooring blocks, hooks, ladders, stairs, fenders, etc., but excluding dredging and filling are, per linear foot: Design A, $550; design B, $540; design C, $550; design D, $490, and design E, $490.

ADVANTAGES OF ADOPTED DESIGN

The sectional type of wall adopted is proving itself to be rapid and economical in construction. It is exceptionally well adapted to the particular features of the bed of the harbor here encountered. Typical block sections, shown in the drawings, have been designed; one for the case where rock is either at the required depth or lower than the required depth of 45 ft. below low water, and the other where rock is above the required depth. In the first case the lower shell is placed upon small pillows or stools of concrete, laid on the solid rock or on a mass concrete or rubble fill at each of its four corners and exactly leveled by means of a large diving bell. Thus the necessity for leveling the whole site is avoided. The mass concrete filling on the bottom will bond with the rough rock and prevent sliding.



DESIGN D—REINFORCED-CONCRETE DECK ON CYLINDER PIERS

A great saving in rock excavation was to be accomplished by the use of the narrow hollow blocks shown in the drawing for the cases where rock level is above the required depth and the rock is in sound solid beds. This factor, combined with the saving in dredging operations due to the scheme for avoiding exact leveling of the site, would add a large element of economy not included in the figures above quoted.

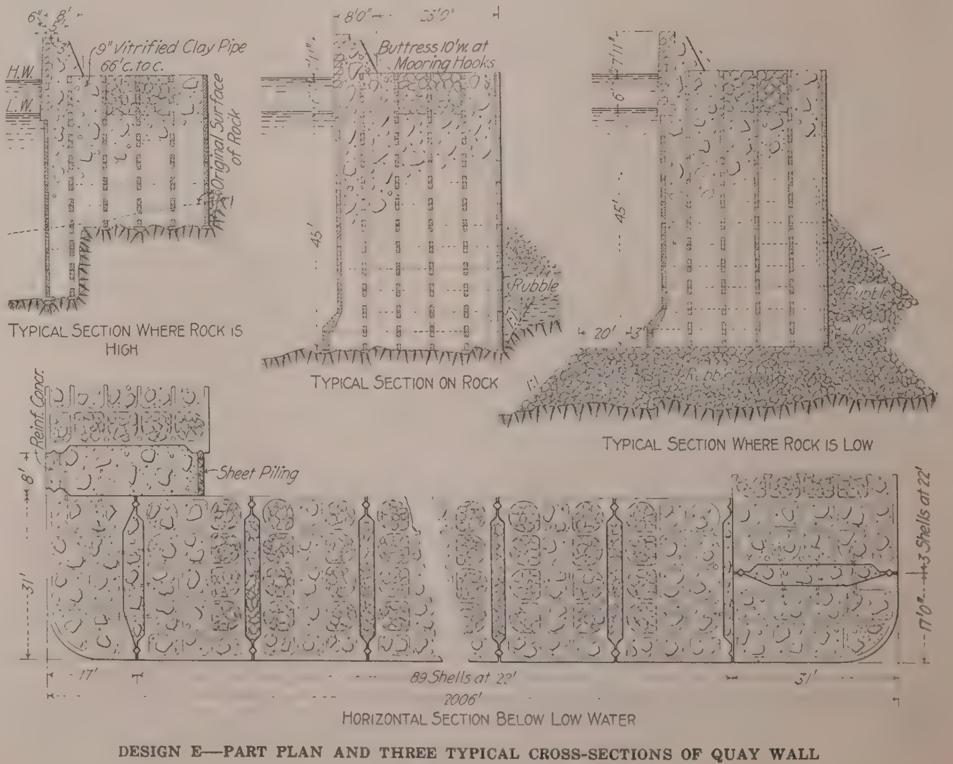
By the use of narrower blocks for the two upper rows, and a rubble concrete wall faced with cut granite masonry from the top down to 1 ft. below low water, the concrete is never exposed to the action of frost between high and low water, thus preventing disintegration.

Other obvious advantages of the adopted design are in the method of setting by a locomotive crane carried on the previously placed part of the wall, thus avoiding the necessity of expensive temporary staging or a floating crane, the advantages in precast units made under ideal manufacturing conditions, and the ease with which the mass concrete can be placed under water in the compartments under relatively good conditions.

ASSUMPTIONS

The governing case with reference to allowable toe pressure and horizontal thrust is the wall built on rubble foundation where rock is low, as shown in the drawing. For this case the whole submerged section is subjected to the full effect of buoyancy. This effect of buoyancy must also be considered for the material backing the wall, not only in modifying the weight, but also the angle of repose. The filling was assumed to be sand or gravel weighing when not submerged 115 lb. per cubic foot with an angle of repose of 38 deg. When submerged the angle of repose was taken at 32 deg.

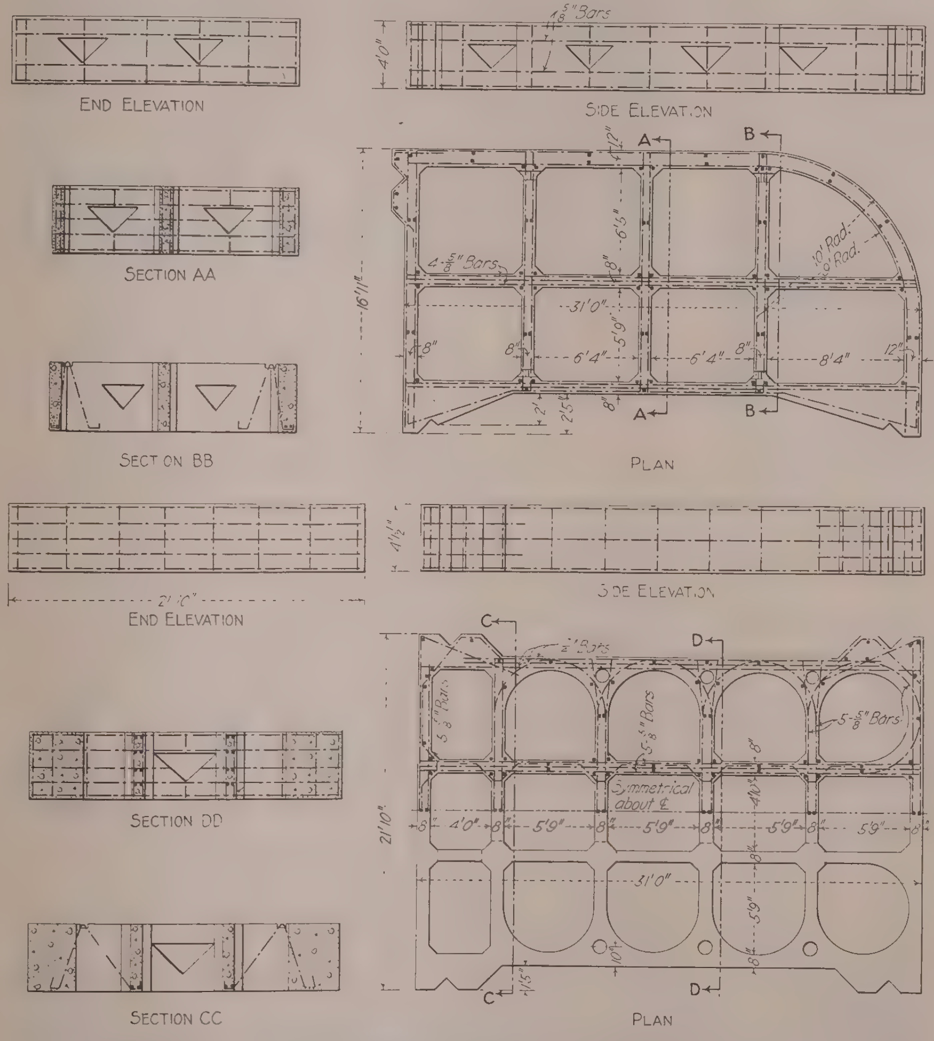
Two theoretical computations of the earth pressure were made, one based upon the Rankine theory of reciprocal pressure and the other upon the sliding wedge hypothesis taking into account the frictional forces on the back of the wall, using the formulas deduced by Poncelet. It was considered that these results gave the maximum and minimum possible values, and that the true pressures were between the two. A surcharge was considered, equal to the height of the backing above the coping plus the superimposed load, and the material was assumed divided into two strata of different



DESIGN E—PART PLAN AND THREE TYPICAL CROSS-SECTIONS OF QUAY WALL densities corresponding to the conditions above and below water level. The angle of friction between the filling and the back of the wall assumed in the second method was 38 deg. above water level and 16 deg. below water level.

RESULTS—RESISTANCE TO SLIDING

For the worst possible case, namely, where the blocks are supported by a carefully prepared rubble mound overlying solid rock, assuming full effect of buoyancy, the following results were obtained: By the Rankine method a maximum toe pressure of 5.7 tons per square foot and a horizontal thrust of 64,000 lb. per linear foot of wall; by the Poncelet method corresponding values of 4.8 tons and 54,000 lb. This maximum toe pressure of 5.7 tons per square foot does not appear excessive when compared with the dock walls at Southampton harbor, England, where experience has shown that a safe unit pressure in quay wall foundations on beds of more or less sandy clay may be taken as 5.4 tons per square foot.



TYPICAL DIMENSIONS AND REINFORCEMENT FOR CORNER AND INTERMEDIATE UNITS OF HOLLOW REINFORCED-CONCRETE BLOCK WALL

Considering the resistance to sliding for this worst case, the computed average weight of wall per linear foot without the superimposed load upon the foundations is 179,000 lb. Assuming a coefficient of friction of 1 at the base of the wall on the rubble foundation, i.e., an angle of repose of 45 deg., the factor of safety against sliding is 2.8 according to the first method, and 3.3 by the second. Since the bottom shell is to be filled with concrete deposited upon and penetrating the rubble bed, these values are amply safe. In all other cases, where the wall is founded directly upon the prepared rock bottom, the conditions will be even more favorable.

INTERNAL STABILITY—DESIGN OF SHELLS

The conditions of stress within the wall unit were investigated by considering the horizontal section immediately above the cantilever toe at the top of the second shell from the bottom. Computing the forces and moments acting on this section and applying equations of equilibrium, the position of the neutral axis was obtained and the stress intensities were calculated to be 120 lb. per square inch maximum compression on the concrete at the front and 115 lb. per square inch maximum tension in the old railway tie rails embedded in the rear compartments, there being practically no uplift.

The general dimensions of the wall and of the shells were fixed by the design of the transit sheds, since the foundations for the front row of shed columns rest on the rear of the quay wall. Thus the 22-ft. length of shells was determined by the column spacing so as to place the columns at the centers of the stacks of shells. The 31-ft. width was based on the requirements for a railway track and for handling freight in front of the shed.

The walls and diaphragms of the reinforced-concrete shells were designed to withstand the bursting pressure due to the rubble or gravel filling in the compartments, in combination with the stresses from all loads acting on the structure. The allowable unit stresses were 500 lb. compression in concrete and 16,000 lb. tension in steel for this case. Analyses for stresses due to a head of unset concrete in the front and middle compartments, for stresses due to dead load when the shells are stacked in the molding yard, and for erection stresses due to the weight of the lifting crane, to lifting, setting and all other causes were made. For erection stresses 25 per cent impact was added. Higher working unit stresses for this case were allowed—700 lb. compression in concrete and 20,000 lb. tension in steel where cracks in the concrete were not injurious.

On account of the important effect of the toe extensions of the two base shells, the unit stress in the steel was kept below 10,000 lb. tension, on the basis of the maximum theoretical toe pressure as a working load, to avoid danger of corrosion of the reinforcement due to salt water entering any tension hair cracks in the concrete. The bottom shell was also analyzed for stresses due to its own weight when resting on the prepared concrete foundation seats at the four corners.

The plans and specifications, designs and comparative estimates for this work were prepared under the supervision of F. W. Cowie, chief engineer of the Montreal Harbor Commission, and a staff of engineers of which James McGregor is superintending engineer at Halifax, A. C. Brown is resident engineer on the dock work and J. J. McDonald is office engineer. F. P. Gutelius, general manager of Canadian government railways, supervised and directed the project, which is being carried out by the Dominion government through the Department of Railways and Canals, of which the Hon. Frank Cochrane is minister.

Deflectometer Gives Direct-Readings of Building Settlements

A DIRECT-READING deflectometer was used in determining the cause of the usual initial settlement in buildings being underpinned along the New York subways. This deflectometer was never used in this country before, according to Maurice Deutsch, consulting engineer, New York City, who used it to make some original tests of piles on this work in September last year. It consists of a steel tape about ½ in. wide attached to the pile being tested and run vertically up and around a small wheel at the end of a horizontal shaft. At the other end of this shaft an index needle is set and revolves around a calibrated dial marked in millimeters, thus giving very exact indications of pile movement.

GOVERNMENT TIMBER AMOUNTING TO 42,578,000 ft. b. m., and valued at more than $93,000, has been cut from the national forests in California in the six months ended Dec. 31, 1915, according to a report recently made by the district forester. This is an increase of almost 43 per cent over the cut for the corresponding period of 1914, and is significant because of the fact that from the latter half of 1912, with a cut of 10,000,000 ft. b. m., valued at $65,000, to July 1, 1914, when a cut of 29,313,000 ft. b. m., valued at $63,669, was made, the government timber industry remained practically stationary.

Smooth Concrete Roads Produced by Accurate Headers

Study of Slight Irregularities in California Pavements Directs Attention to Need for Screeding Surface at True Grade

THAT the smooth-riding qualities of concrete roads are dependent more upon the use, during construction, of headers of true shape, set accurately to grade, than to screeding devices and floats, is the conclusion reached by Charles H. Wondries, resident engineer of the California Highway Commission, in a report submitted recently to Austin B. Fletcher, chief engineer. In the effort to get a smooth pavement the screeding device and float are limited, even under the most skillful handling, by the trueness to grade of the headers upon which the screed rides and from which the float works.

←

SCREEDING SURFACE OF CALIFORNIA CONCRETE ROAD

Header Board Abuses

In keeping with the rule requiring the maximum use of equipment, it has been the custom in road work to use header boards repeatedly. Ragged ends are occasionally sawed off, or strips which have been warped by alternate wetting and drying are partially sawed by way of correction, but headers are seldom rejected because the ends are partially broken and shattered, or because the body of the rule is slightly warped or splintered. These header boards perform a dual function, but the retaining of the concrete in the subgrade is a less delicate matter than marking the elevation to which the concrete should be finished. It has therefore been found worth while in California work to make special provision for checking and correcting inaccuracies which are likely to interfere with the latter function.

Numerous checks extending over various portions of 40 miles of pavement with 16 and 22-ft. straight edges in three Southern California counties showed that invariably, after the first day or two of pavement laying, during which the concrete crew accustoms itself to its working tools, the apparent rough-riding qualities of the finished concrete can be traced to warped strips and high or low header joints. The deflection from a straight line in these headers varies from unappreciable amounts to about ⅜ in. The results of this study have been the adoption of a 2 x 4-in. rule from 16 to 24 ft. in length for detecting minor warps in headers, and high and low joints. This check is applied in addition to the chalk-line and sighting tests ordinarily used.

This test with the 2 x 4-in. straight edge is not made, however, until a few hours before the concrete is actually placed between the headers. It has been found that under conditions on the California highways the concrete foreman, without neglecting his other work, can check up and correct enough rules during the day to keep ahead of his crew. Where headers are found to be warped the new practice requires driving additional outside stakes to which the headers are securely nailed after being raised or lowered to check with the straight edge. The old custom of sawing off part of the warped header, it is pointed out, simply decreases the length of the arc.

→

SETTING RULES TO MEET STRAIGHT EDGE

The morning after the concrete is placed, or the same day when possible, the straight edge is tried upon the finished concrete and any variation from a straight line is traced back to header, screed or float trouble. While this work of checking the finished pavement is going on, the men in charge of the crews are shown the possible causes of the variation from a true grade and remedies are suggested.

Checking with Straight Edge

This straight-edge method of checking does not show results in the close-range inspection of the completed work, but it results in a very appreciable improvement in the smoothness of the roadway surface and has made it possible to lay long stretches of concrete pavement with variations which were nowhere found to exceed ⅛ in. under a 20-ft. straight edge. This degree of smoothness adds much to the comfort and pleasure of driving over the road at 20 miles per hour or more.

It is not sufficient, the commission has found, to have the headers carefully set to grade and checked with a straight edge. Insistence must be placed on a gentle tamping of the concrete with the heavy wooden tamper which is now generally used, instead of vigorous blows which result, among other things, in deflecting the header from exact grade.

It has also been observed that where a very dry mix adjoins very wet concrete, even though practically perfect grade may be maintained over the entire surface, the surface will not be regular after the final set is attained, due to the difference in final volume of the two grades of material. Assuming uniformity of mix, if the concrete is spread out with shovels and screeds after it has left the mixer spout, and is first given a general tamping to close the inner voids and bring sufficient mortar to the surface to permit the float to close the surface voids, there was no trouble in going over the pavement finally with the long back and forward sweeps of the screed which would smooth off any local mortar inequalities and would permit of a very close checking with the rule on the finished pavement.

CLEANING RULES AND SMOOTHING SURFACE WITH FLOAT

Analysis and Tests Held to Show Advantages of New Flat-Slab Reinforcement

Part 1—Stress Conditions Discussed with Relation to Deflection Contours and Economical Placement of Steel in Smulski System

By EDWARD SMULSKI
Chief Engineer, S-M-I Flat Slab System Company, Boston

WITHOUT attempting to obtain or recommend coefficients for bending moments, the action under load of flat slabs with multiple reinforcement has been investigated by the author, both in the theoretical analysis presented herewith as Part 1, and by a series of tests on eight slabs in which the deformations and stress relations were carefully measured, the results of which will be presented in Part 2, to follow. This investigation shows the advantages of the new system of flat-slab reinforcement shown in Fig. 1 and described in the article on the Youth's Companion Building at Allston, Mass., in the Engineering Record of Oct. 9, 1915, page 450, and called the Smulski or S-M-I system.

CONTOUR LINES SHOW DEFLECTION

The action of the flat slab can be best understood by considering its deflection under load. For this purpose contour lines of a slab after deflection are shown in Fig. 2, based on results of tests made by A. R. Lord on the Deere & Webber Building and published in Bulletin 64 of the University of Illinois. The size of the test panel was 18 ft. 8 in. x 19 ft. 1 in. For a load of 350 lb. per square foot the deflection at the center, point C, was 0.32 in., while the average deflection at points C_1 and C_2 was 0.22 in.

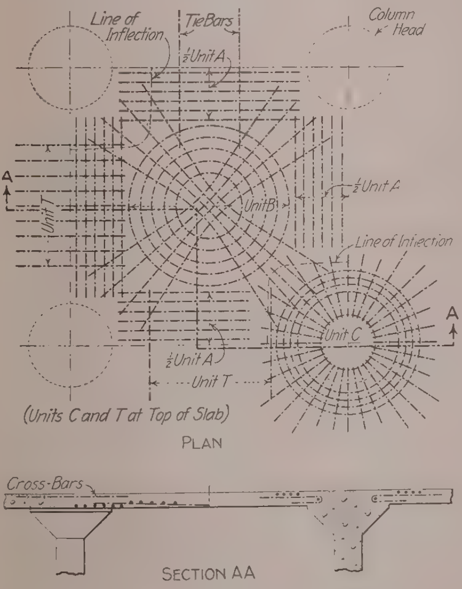


FIG. 1—NEW TYPE OF REINFORCEMENT

The contour lines were drawn by first plotting the deflections along the diagonal and rectangular lines as shown in the sections, Fig. 2, then using horizontal lines 0.04 in. apart to locate points of intersection with the neutral axis after deflection, transferring these points to the plan view and connecting the points of equal deflection by smooth curves showing the shape of the slab after deflection. The heavy dash lines around the columns give the location of the points of inflection from Mr. Lord's tests.

EFFECTS OF LOADING

The contour lines given are for the case of several spans loaded, which is the most unfavorable condition because then the maximum stresses are obtained at the column head. When one span only is loaded, the stresses in the center of the span are somewhat larger, but at the column head they are comparatively small, because the load not only is carried by the loaded panel but also is transferred to the unloaded panel. In other words, the negative bending moment is resisted by the column head and by the unloaded adjacent slabs.

The contour lines show that the slab can be divided into two parts, the circumferential cantilevers at the column head subjected to negative bending moment and the central portion of the slab subjected to positive bending moment. These two parts will be treated separately.

DEFLECTIONS AT THE COLUMN HEAD

From the shape of the contour line, it is evident that the circumferential cantilever at the column head assumes the shape of an umbrella. In Fig. 3, showing the circumferential cantilever to a larger scale, point *a* on the top of the slab, due to the deflection, changes its position to *a′*, consequently the radial distance from the center of the column is increased by *aa′*. Due to this increase of the radius, the circumference of the circle through *a* after the deflection is increased, as indicated by the dotted lines through *a′*. The particles above the neutral axis, therefore, are stretched in two directions perpendicular to each other, i.e., in a radial direction on account of the increase in radius and in a circumferential direction on account of the increase of circumference. The circle through *b* at the bottom of the slab assumes, after deflection, the position through the point *b′*, and therefore all particles here compress in two directions, i.e., in a radial direction and in a circumferential direction.

From the above discussion it is evident (1) that the stresses act in radial and circumferential directions, (2) that the radial component of the compressive stresses, which is the largest part of the compression, must finally be transferred to the columns.

As is evident from the shape of the contour lines and from the foregoing discussion, the slab may fail in compression by crushing of concrete around the column head. The width of beam resisting this crushing of concrete is equal to the circumference of the column head. Therefore, in determining the compressive stresses or the depth of slab for a bending moment around the total circumference, the circumference of the column head must be taken as the effective width of the slab.

REINFORCEMENT OF FLAT SLABS

It is a well-known principle that the best method of resisting stresses is by means of members placed in the direction of the stresses. The same applies to the design of flat-slab reinforcement. The direction of stresses can be seen from the contour lines, because the stresses act perpendicularly to them.

At the head of the column the stresses act radially and circumferentially; therefore, the logical method of reinforcing the slabs is by using radial and circumferential bars. The radial bars take the stresses acting in radial directions. The purpose of the rings is twofold: (1) to resist the circumferential bending moment, which acts in every point as a tangent to the ring and (2) to resist the radial stresses by its hooping effect. In such a combination the radial bars and the rings act co-ordinately, as will be seen from the tests of circumferential cantilevers to be described in the following Part 2.

The action of the rings in resisting radial stresses can be seen from Fig. 3. A section *ab* tends to assume the position of *a′b′* after deflection, and the distance *ma* on the top is increased in amount after deformation. The same would apply to any section around the circumference of the circumferential cantilever. Suppose that a ring is placed near *a*. In order to allow movement in a radial direction, it is necessary to stretch the ring by increasing its radius. The resistance of the ring to the increase of the diameter, therefore, resists the movement *aa′*.

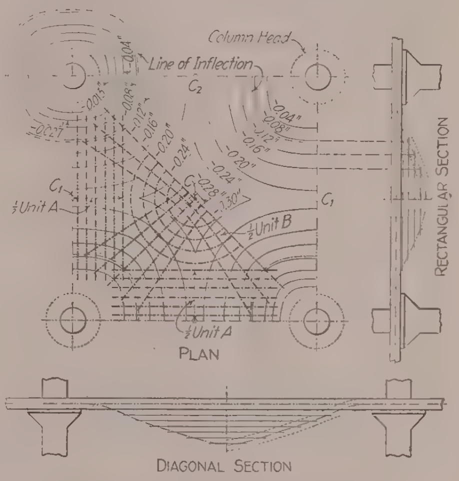


FIG. 2—RELATION BETWEEN DEFLECTIONS AND NEW SYSTEM OF REINFORCEMENT

DISTRIBUTION TO SEVERAL RINGS

If more than one ring is used, any radial movement within the portion of slab covered by the rings is resisted by all the rings placed outside of the point where the movement takes place, because before any movement can take place, it has to increase the radii and the circumferences of all the rings. Therefore all rings participate equally in resisting the stresses. This is shown in Table 1 and stress diagrams in Part 2, which give the results of the tests on circumferential cantilevers.

Compressive reinforcement at the column head is very often required. Tests indicate that the compressive stresses at the column head are larger than would correspond to the actual stresses in steel. This is partially due to arch action, which undoubtedly takes place in flat slabs. Therefore in many cases it is essential to provide compressive reinforcement at the column head. In the type of reinforcement discussed, this is provided by the compression prongs of the radial bars, which are carried near the bottom of the slab. (See cross-section in Fig. 1.)

In the portions of the slab covered by Units *A*, drawn on Fig. 2, the contour lines are practically parallel, which shows that the stresses act in one direction only. The reinforcement, therefore, is placed in one direction only, straight between the columns.

The reinforcement of the central portion of the slab consists of rings combined with diverging bars, because the stresses in the central portion of the slab act in four directions, as indicated by the contour lines. The rings in this Unit *B* not only take the stresses produced in the diagonal sections, Fig. 2, where they are nearly perpendicular to the contour lines, but also resist any tendency to deformation in the diagonal direction, thus helping the diverging bars, which are placed very nearly perpendicular to the contour lines, and in the direction of the stresses. The spacing of diagonal rods is close in the center of the slab where the deflection and the stresses are largest. The rods diverge at the ends to supply reinforcement in portions where the circles end and also to bind securely the central portion of the slab to the circumferential cantilevers.

SECONDARY REINFORCEMENT

If only one span is loaded, the shape of contour lines changes at the column head and across Units *A*, where negative bending moment develops. This is resisted by secondary reinforcement in Units *A*. In the central portion, however, the change is slight, so that the discussion given above applies equally to any condition of loading.

Secondary reinforcement consisting of straight bars is, as a rule, placed at the top of the slab across Units *A*. As is evident from inspection of the contour lines, Fig. 2, this reinforcement does not come fully into action when the load is distributed over all the spans, because there is no appreciable transverse deformation at Units *A*. This reinforcement is fully effective in resisting negative bending moment produced when only one span is loaded.

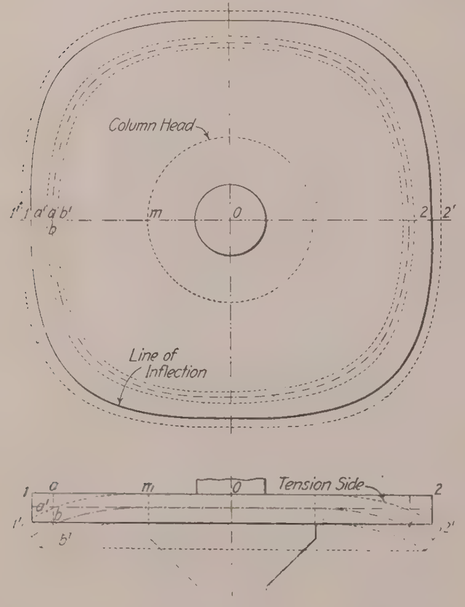


FIG. 3—CANTILEVER ACTION AT COLUMN

THEORETICAL COMPARISON

In comparing reinforcement placed in the direction of stress with reinforcement placed in bands as in the two-way or four-way systems, the statical bending moment, although it does not represent the actual conditions, furnishes a correct and convenient basis for determining the relative effectiveness of the two methods of reinforcing. In systems where bands of steel rods are used, it is necessary to resolve the actual bending moment acting in radial directions into components acting in the direction of the bands. The moment of resistance to be provided (equal to the sum of the components of the radial bending moment) is therefore larger than the actual bending moment. (See test specimens No. 7 and No. 8, Part 2.)

In the radial system, on the other hand, stresses acting in any direction are resisted directly by the circles and radials, as discussed above, and the moment of resistance to be provided equals the actual bending moment around the column head. The ratio of the required areas of steel for the two cases will now be found.

BAND REINFORCEMENT

In a paper before the American Society of Civil Engineers, printed in the *Proceedings* for April, 1913, J. R. Nichols develops the statical bending moment in a flat slab. On page 1735 the sum of components of positive and negative bending moments in one direction (equivalent to bending moment per quarter of circumference of the column head) is given as

$$M_x = \frac{wL}{8}\left(L - \frac{2}{3}D\right)^2$$

where *L* is the span in feet, *D* is the diameter of the column head and *w* is the load per square foot. Assuming $D = 0.24L$,

$$M_x = 0.71\frac{wL^3}{8}$$

As in continuous beams, the negative bending moment equals two-thirds M_x; therefore, in inch pounds per section

$$M = 0.71wL^3$$

and the required area of negative bending moment reinforcement per section is, in square inches,

$$A_s = \frac{0.71wL^3}{f_s jd}$$

It must be remembered that full negative reinforcement consists of four such effective sections (two per band). This will be compared with the amount of steel required by the radial system in one-quarter of a circumference.

The above figures giving the static bending moment are used for sake of comparison only, and are not recommended for use. The actual bending moment to be provided for is smaller, as it is reduced by Poisson's ratio, due to the fact that the stresses are acting in two directions. The ratio between the static bending moment and the actual bending moment, therefore, was selected so as to avoid comparing moments based on different assumptions.

RADIAL REINFORCEMENT

The best method of determining the statical bending moment in a flat slab is by dividing it into a number of simple statically determinate members. The practicability of this method follows from a consideration of continuous beams. Assume a continuous beam under uniform loading *w* per foot extending over numerous supports. The negative bending moment at the supports is $wl^2/12$ and the point of inflection is distant $0.21l$ from the support. By introducing hinges at the points of inflection, the center portion between the hinges, equal in length to $0.58l$ will be a simply supported beam producing reactions at the hinged point equal to $0.29wl$.

The remaining two portions of the beam will be simple cantilevers loaded with concentrated loads at the points of inflection and a uniformly distributed load *w* between the point of inflection and the support. It is evident that a continuous beam may be changed into statically determinate beams by inserting imaginary hinges at the points of inflection, because there is no bending moment at these points and the only force acting there is the shear, which is equal to the reaction $0.29wl$ of the imaginary center beam.

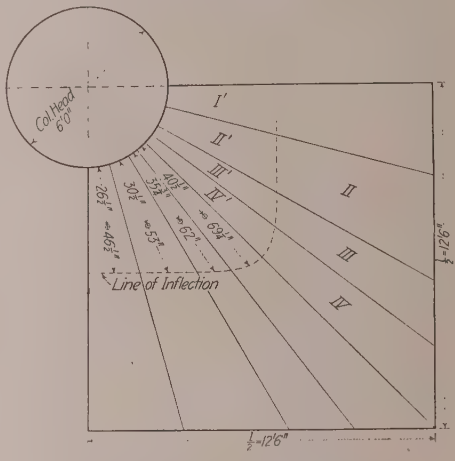


FIG. 4—TO DETERMINE STATICAL BENDING MOMENTS AROUND COLUMN HEAD

APPLICATION TO FLAT SLAB

Fig. 4 shows an outline of a 25-ft. span in which the column head (6 ft.) is assumed as 0.24 of the span, as before. The distance of the point of inflection from the edge of the column head is assumed at one-fifth of the clear span, which is equivalent to the assumption made for the distribution of the bending moments in the case with band reinforcement. There is no shear along the center lines of the panels nor along the lines between columns, under full loading on all panels, therefore the quarter of the panel can be treated separately. For partial loading the theory is modified by the shear acting at these lines.

As explained in connection with a continuous beam, the portion of the load in the span outside of the points of inflection can be considered as suspended at the points of inflection. To get the proper moment arms for the different loads in different portions of the panels, the slab is divided by imaginary radials into parts I, II, III, IV. etc. The division lines are not sections and are made only for the purpose of figuring the areas. Having found the areas and lever arms, the resulting coefficient is computed as in the table herewith, and the bend-

COMPUTATION OF MOMENT COEFFICIENT

No.	Area	Moment arm	Moment factor
I	14.8	46.5	688
II	16.8	53	890
III	10.3	62	639
IV	13.2	69.25	915
I'	5.1	26.25	134
II'	5.9	30.5	180
III'	3.9	35.75	140
IV'	4.7	40.5	190

Total moment factor per ⅛ circumference, 3776
Total moment factor per ¼ circumference, 7552
Coefficient = $7552/25^3 = 0.48$

ing moment is $M = 0.48wL^3$ in inch pounds, and the required area of steel is

$$A_s = \frac{0.48wL^3}{f_s jd}$$

The above bending moment will be resisted by radial bars and rings; therefore the area A_s, consists of the cross-section of radials within the quarter of circumference, and the cross-sections of rings. For the reasons explained in connection with moments for the band system, the above figures give higher results than required in practice and are intended for comparison only.

By comparing the areas of steel A_s required in the two cases (coefficients 0.71 and 0.48), it is found that the required cross-sectional area to be supplied by the new type of reinforcement resisting the direct stresses is 33 per cent smaller than required in the older systems placed in bands. In both cases, the areas of steel were figured on exactly the same basis.

[*To be concluded in the next issue. Results of tests and description of unique testing methods will be given in Part 2. Specimens of two-way and four-way slabs are tested for comparison with the tests of the new radial and circumferential reinforcement.*—EDITOR.]

Remodel Septic Tank Into Two-Story Tank

Pioneer Plant at Lake Forest, Ill., Built Fourteen Years Ago, Outgrown in Capacity, Changed to Modern Design at Small Cost

FOURTEEN years ago septic tanks were considered the last word in sewage treatment, and the 50,000-gal. tank at Lake Forest, Ill., built by Alvord & Shields, was the Mecca to which many sanitary engineers journeyed. Last year the old plant, neglected for several years, and outgrown as to size, became such a nuisance that the city officials had it remodeled into a two-story settling tank. N. N. Campbell, assistant city engineer, gave a history of the old plant and the reconstruction of the new one in a paper presented Jan. 27 to the Illinois Society of Engineers and Surveyors, from which the following notes are taken.

REPAIRS BADLY NEEDED

During the thirteen years the plant was in operation it had been cleaned only twice, once in 1907 and again in 1909. The average annual cost of operation and repair during this period was $534.79.

The physical condition of the plant gradually grew worse. The troughs and partitions in the filter beds had rotted and broken considerably, the tank walls about the surface of the ground were in need of repairs and a few slight leaks were noticed. The piping in the dosing chamber and the automatic operating device were badly rusted and likely to give away at any time. On the whole it became evident that something must be done at once to put the plant in such repair that it would take care of the sewage for at least a few years, or until such time as the proposed sanitary improvements along the North Shore were more fully developed.

In 1913 S. A. Greeley found that 30 per cent of the daily dry-weather flow was bypassed into the lake directly, 70 per cent was treated in the tank and only 24 per cent went through both tank and filters. Analyses indicated an effluent from the tank of poorer quality than the influent, and the effluent from the filters was little improved.

The work of remodeling the tank consisted of removing the old floor, underpinning the old walls and excavating to an additional depth of from 3 ft. 6 in. at the inlet end of the tank to 8 ft. 6 in. in the dosing chamber. A new reinforced-concrete floor 9 in. thick, making an angle of 30 deg. with the horizontal and sloping from each side toward the center of each chamber, was put in to replace the old floor. The water level in the tank was raised 1 ft., the total depth of the remodeled tank being 12 ft. 6 in.

THREE UNITS IN REMODELED TANK

The remodeled tank consists of three units, each of which is divided by a 9-in. concrete wall into two equal chambers. Each chamber is divided into three compartments by means of a false bottom constructed of 20-gage galvanized iron on a framework of No. 1 2 x 4-in. pine strips, heavily creosoted, making a slope of 60 deg. to the horizontal. The three units are in reality a series of three settling tanks. The liquid is drawn off from the top of each unit, as it passes on to the next, over a brick wall or partition separating the units and rising to within 12 in. of the surface. It finally emerges at a point 14 in. below the surface and discharges at the shore of Lake Michigan.

Three baffles or scum boards, 18 in. high, and extending down into the liquid 12 in., were placed across the tank at intervals so as to break up any surface currents that might develop.

The method devised to distribute the sewage to the several compartments is unique and very efficient in breaking up currents or vortex motion in the settling compartments. The sewage enters the tank from the remodeled grit chamber through a 3-ft. opening or trough in the center of the end wall, which leads into a reinforced-concrete distributor running parallel with the end wall and placed so as to leave a 9-in. space between the 18-in. square distributor and the wall. There are four rectangular openings in this channel, 6 x 15 in., which discharge the sewage into each of the four settling compartments against the end wall of the tank in the opposite direction to which it must flow through the settling compartments.

The collector is a rectangular trough or channel similar to the distributor and is placed 9 in. from the outlet end of the tank with the openings in the side next the end wall. The collector also serves as a scum board or trap and prevents any light floating sludge from being drawn off with the effluent.

The sludge drying bed is 90 ft. long and 20 ft. wide, and is parallel with the tank and 20 ft. from it. The bed is divided into three sections by concrete partitions. Each section receives the sludge from one of the three units of the settling tank and is underdrained with four lines of 6-in. drain tile leading into an 8-in. carrier which discharges into the pipe leading from the settling tank. The underdrains of the sludge drying beds are covered to a depth of 12 in. with common lake-shore sand and gravel.

ALTERATIONS COST $4,000

The cost of remodeling the Lake Forest plant and enlarging it so as to provide for the increased amount of sewage was about $4,000.

Some of the elements in the remodeled tank are the provision for 680,000 gal. daily dry-weather flow; settling capacity of 5670 cu. ft.; sludge space of 4000 cu. ft.; settling period, 1.4 hours; velocity through tank, 1 ft. per minute.

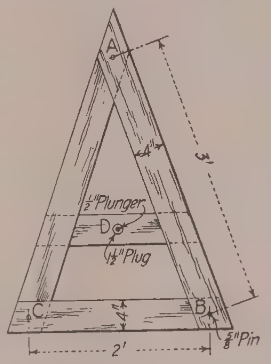
The tank was put into operation Dec. 6, 1915. On Jan. 21 one of the sludge drains leading from a unit nearest the inlet end of the tank was opened and about 10 bbl. of heavy sludge were drawn off before the sewage flowed freely from the pipe. The sludge was apparently well digested and had very little odor.

The plans were prepared by Mr. Campbell under the general direction of James Anderson, Jr., city engineer.

Replace Stakes by Monuments Without a Transit

Triangular Wooden Frame with Pointed Steel Legs Marked Auxiliary Stakes, Permitting Easy Recovery of Original Point

IN MAKING a re-survey of the city of Portage, Wis., it was desired to place at each block corner a permanent concrete monument upon which would be marked the point of intersection of the property lines. As the survey progressed, temporary wooden stakes were set at each corner, the exact point being marked by an ordinary cup tack driven into the stake. In order to replace the wooden stake with a concrete monument upon which would be permanently marked the point referred to, a triangular frame, as shown in the accompanying sketch, was devised.



CENTER PUNCH PLUNGER ON TIMBER FRAME MARKS MONUMENT

The frame was made of well-seasoned yellow pine. The parts were glued and securely fastened together with wood screws, making the frame perfectly rigid. At the points *A*, *B* and *C*, $\frac{5}{8}$-in. steel legs were inserted and clamped to the frame by means of locknuts. The lower ends of the legs were pointed bluntly to resemble an ordinary center punch. The frame was easily and quickly leveled by means of the locknuts. At *d* a hardwood plug 2 in. long and $1\frac{1}{2}$ in. in diameter was fitted into the piece. In the center of the plug was a $\frac{1}{2}$-in. hole through which a steel plunger 10 in. long worked. The plunger was also bluntly pointed.

HOW DEVICE WAS USED

The method of using the above device is obvious. The point of the plunger was placed on the tack in the stake, and three stakes were driven at the points *a*, *b* and *c*, a cup tack being driven into each stake under the point of each leg. If one or more of the legs fell upon the sidewalk, a light tap on the top of the leg bolt made a punch mark in the concrete, thus marking the point. The stake marking the corner of the block was then removed and the hole for the monument was dug and filled with concrete. After the concrete had been

PORT WELLER HARBOR, WELLAND SHIP CANAL, AS IT APPEARED IN AUGUST, 1915—CONCRETE CRIB BEING TOWED TO PLACE

brought to the required height a soft iron pin was placed directly beneath the plunger. After the concrete had hardened for several days the frame was again placed upon the reference points, and a punch mark was made upon the iron pin by tapping the plunger with a hammer, thus marking the desired point on the monument. Care was taken to have the frame practically level and to set the reference stakes so that there would be no danger of their being disturbed. The original distance between the points of the legs was kept constant by frequent comparisons with a set of standard tacks which were set with the frame at the beginning of the work.

H. V. Tennant, city engineer, under whose direction the survey was made, states that the method as it was here used proved very practical, an average of sixty monuments a day being attained.

Twelve 2000-Ton Cribs for Welland Canal Completed

Excavation Well Under Way at End of 1915—Embankments to Form New Harbor Entrance More Than 50 Per Cent Complete

TWELVE of the 2000-ton reinforced-concrete cribs for the Welland ship canal were completed at the end of 1915. More than 50 per cent of the material necessary to form the embankments for the Lake Ontario entrance had been deposited, and substantial progress had been made on the excavation of all sections. No new contracts were let during the year.

At the end of the year a total of 4,900,000 cu. yd. had been deposited in embankments forming the harbor entrance. The trestle on the west side, from which the material is dumped, has reached the outer extremity of the harbor, projecting 1½ miles into the lake, while the east trestle is out approximately 5500 ft. from the shore line.

Twelve of the large 2000-ton reinforced-concrete cribs to be used for the substructure of the entrance piers and inner harbor dockage have been built, and seven of them sunk in position on the work—five on the site of the outer entrance piers and two on that for the inside docking.

EXCAVATION IN SECTION 2

Section 2, about 4½ miles in length, includes the excavation of the canal prism involving the removal of about 6,500,000 cu. yd. of earth, the construction of locks 2 and 3, with entrance walls, weirs, etc., and the substructure for several bridges over the canal.

WEST WALL OF LOCK 1

Four large steam shovels and three dragline excavators have been engaged on prism excavation, and, to the end of the year, 4,300,000 cubic yards of earth were excavated, the greater part of it being disposed of in the harbor embankments.

Concreting in the breast wall at the head of lock 2 was completed during the summer, and work on the lock walls commenced about mid-season. The upper entrance walls, which are of mass concrete, are practically completed.

Section 3 involves the construction of the twin locks in flights 4, 5 and 6, single lock 7, the guard gates, the construction of the large dam at the head of lock 6 and the excavation of approximately 2,700,000 cu. yd. of rock and 3,400,000 cu. yd. of earth.

Operations on this section have consisted largely of earth and rock excavation. To Dec. 31, 850,000 cu. yd. of rock were excavated from the site of the flight locks, and approximately 1,850,000 cu. yd. of earth were removed. Rock suitable for concrete is taken to the large crushing plant at the lower end of the section and crushed for aggregate for sections 1 and 2.

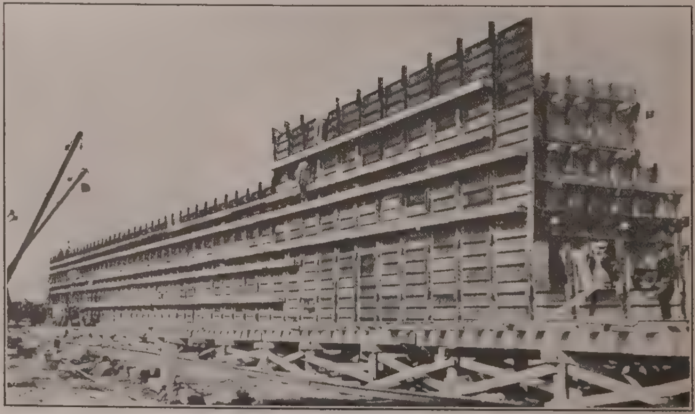
PRESENT CANAL DEEPENED

Section 5, consisting of the widening and deepening of the present canal between Allanburg and Port Robinson, a distance of 2½ miles, was worked by four steam shovels in the dry excavation and four dredges in the channel. The dry excavation removed totaled 2,900,000 cu. yd. of the 5,400,000 cu. yd. to be excavated. Four dredges have been at work in the channel, deepening the canal from the present 14-ft. to the new 25-ft. depth.

Colorado River Attains Highest Stage on Record

THE GREATEST known discharge of the Colorado River at Yuma, Ariz., was experienced Jan. 22, when the gage located at the Southern Pacific railroad bridge which crosses the river at that point registered 34 ft., and the approximate discharge was more than 200,000 sec.-ft. Previous high-gage readings occurred in February, 1891, when the gage read 33.2; in March, 1905, when 30.4 was registered; in November, 1905, when 31.4 was reached, and in June, 1909, when, with a gage of 30.75, there was a discharge of approximately 150,000 sec.-ft.

CONCRETE CRIB SUNK TO POSITION AT SITE OF OUTER ENTRANCE PIERS, PORT WELLER



STEEL FORMS BEING SET UP PREPARATORY TO CONCRETING EAST ENTRANCE WALL, LOCK 6

The latter discharge had represented the greatest measured discharge of the Colorado River since current-meter measurements have been made.

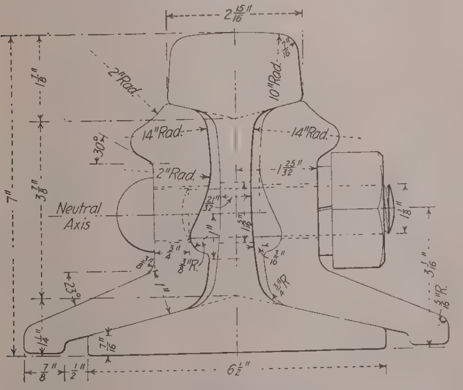
The unprecedented gage and discharge during the recent flood was caused by run-off from the upper Gila River. While the Colorado was slightly above normal for this time of year, due to local rains, the main body of the flood came from the Gila, which joins the Colorado two miles above Yuma. On Jan. 19 the gage at 2 p. m. was 18.2, with a discharge of 14,000 sec.-ft. On the following date the gage was 23, and the discharge approximately 52,000 sec.-ft. Beginning on the first-mentioned date, the gage rose steadily approximately 0.25 ft. per hour, reaching the crest given above on the evening of Jan. 22. The decline, which began early in the morning of Jan. 23, was at about the same rate as the increase. At noon of the day of highest level, when the gage read 32.9, the measured discharge was 109,000 sec.-ft.

The measured area of the river section on Jan. 21 was 12,075 sq. ft., with a mean velocity of 9 ft. per second. After the crest had been reached, on Jan. 24, the area was 12,700 sq. ft., with a mean velocity of 6½ ft. per second. The estimated area based on soundings before and after the flood, with the increased gage height, is estimated to have been approximately 19,000 sq. ft., which, with a mean velocity of 11 ft. per second, would give 208,000 sec.-ft.

Lehigh Valley to Try Out 136-Pound Rail

Experimental Rail, for Which Only a Small Order Has Been Placed, Is Heavier Than Any T-Rail Yet in Use

A RAIL weighing 136 lb. per yard—heavier than any T-rail previously laid, comparing with the 125-lb. rail newly adopted by the Pennsylvania Railroad and the special 135-lb. rail used for several years on sharp curves on one division of the Central Railroad of New Jersey—is about to be tried out by the Lehigh Valley Railroad. The dimensions of the new section are shown below. As the rail is experimental, only a small order has been placed. The original order is for 2500 tons, which will be placed on heavy-traffic track with heavy curvature.



CROSS-SECTION OF LEHIGH VALLEY 136-LB. RAIL AND SPLICE

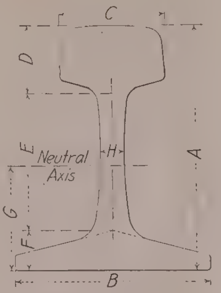
	Area Sq. In.	Area Per Cent
Head	4.72	35.4
Web	3.17	23.7
Base	5.46	40.9
Total	13.35	100.0

Moment of inertia	86.57
Section modulus, head	21.98
Section modulus, base	28.27

It is natural to compare the new sections with the Pennsylvania and the Jersey Central sections above mentioned, and with the 130-lb. and 140-lb. sections offered last year by the rail committee of the American Railway Engineering Association. The above table of main dimensions has therefore been prepared, affording a ready comparison of the five sections. It will be seen that the Lehigh Valley section differs radically from that of the Jersey Central, which was admittedly designed for a very special purpose, and was in addition a pioneer among heavy rails. Whereas the extra weight of the Jersey Central rail is mostly in the head and web, that of the Lehigh Valley is to a considerable extent in the base. The upper part is more like that of the Pennsylvania 125-lb. rail, but the rail has a thinner web and a wider base. The head and web of the Lehigh Valley section is in fact almost identical with those of the 130-lb. A. R. E. A. section, but the base is wider than that of the 140-lb. A. R. E. A. section, while the height is the same as that of the 140-lb. section, and more than that of any of the others.

The new rail section was designed by G. L. Moore, engineer maintenance of way of the Lehigh Valley Railroad.

COMPARATIVE CROSS-SECTIONAL DIMENSIONS OF FIVE HEAVY RAILS



	136-lb. Lehigh Valley	135-lb. C. R. R. of N. J.	125-lb. Pennsylvania	130-lb. A. R. E. A.	140-lb. A. R. E. A.
A	7	6 1/2	6 1/2	6 3/4	7
B	6 1/2	6	5 1/2	6	6 1/4
C	2 15/16	3 5/32	*3	2 15/16	3
D	1 7/8	2	1 7/8	1 27/32	1 29/32
E	3 7/8	3 9/32	3 13/32	3 11/16	3 27/32
F	1 1/4	1 7/32	1 7/32	1 7/32	1 1/4
G	3 1/16	.....	3	3 1/32	3 9/64
H	21/32	3/4	23/32	21/32	11/16

*Faces of head are vertical.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Municipal and Public Contracting

SIR: An interesting example of competitive municipal and public bidding on county work has recently been evidenced at Los Angeles in connection with the erection of four steel and concrete bridges along the state highway in the northwestern section of the county, with contract awards resulting in favor of the public contractors. The county road commissioner surprised both the Board of Supervisors and general contractors by submitting bids for the work in the name of Los Angeles County, basing the estimates on the actual cost of the work, with the addition of a safe margin for any contingencies that might arise, or on the same conservative basis as the public contractor is presumed to figure.

The county's bids were among the high proposals for the work, standing third from the lowest in one instance, seventh in two others and ninth in the fourth case, for the four bridges, respectively. Owning a pile driver, the county was in position to estimate on this particular feature of the work to the best possible advantage, yet it could not approach the figures of the regular contractors. The bidding resulted in the awarding of contracts for the four structures to one contractor, Mesmer & Rice, at an aggregate price of $106,326.50.

For a municipality or county to enter into competition with general contractors on public work, figuring its proposals on exactly the same basis, presents a condition that consistently conforms to the policy of public welfare, yet such dual bidding occurrences are very infrequent. Contractors can hardly object to this action where the municipal bid is rightly and fairly figured under safe margin, and allows no pleas for further appropriations owing to unexpected difficulties in executing the work not foreseen.

With municipal bids accurately estimated, general contractors, while having greater competition, enjoy an equal if not better opportunity for receiving the contract award. And in addition, the tendering of bids by both municipal and regular contractors tends to alleviate from the public mind any suspicion of collusion between contractors and accordant seemingly excessive prices for public improvements.

The result in the Los Angeles incident tends to show that the experienced contractor with an efficient organization can estimate and build more cheaply than a city, county or state can expect to do.

L. R. W. ALLISON.

Newark, N. J.

Co-operation to Save Duplication of Field Surveys

SIR: A few words regarding co-operation of the several departments of our railroads which have engineering forces, such as the real-estate, maintenance and construction branches, may be of interest.

Many times a party is sent out from one of the three named departments to take some sections, get some topography or locate some fence lines, or other data, which information is already in the hands of one or both of the other departments. It means much time lost and expense incurred which could be eliminated by a systematic filing of notes, notebooks and plans, and by hearty co-operation, as soon as changes occur, between all concerned.

This valuation work has brought departments together and given one a glimpse of co-operation, but I fear that as soon as the work is completed little or no effort will be made to keep the plans up to date. A central office giving access to all departments needing engineering information which should be kept up to date by cooperation would do much to save time and expense.

Most railroads have complete surveys and a wealth of information concerning future line changes and improvements, but often have I witnessed maintenance engineers sent out to get a mile or so of profile, or half-mile or so of cross-sections, for a siding, perhaps, when all such information is in the construction engineer's office. If information were systematized all that would be necessary to get this information would be to request a profile between stations so and so, or cross-sections on the west side between such and such a station.

A four-man party usually costs between $8 and $11 a day without overhead charges, and very often when sent out to get a few levels, or a little topography, with time spent in travel, does not get time to do anything else, although the information secured may have taken only a few hours.

Perhaps great changes will result from the valuation work, and if so it will only be for the railroads' benefit, as economy is so much desired by all.

New Haven, Conn. CHAS. A. GOELZ.

[Mr. Goelz has undoubtedly made a good suggestion. It is customary on some railroads, at least, for one department, when it needs information from the field, to disregard entirely the possibility of some other department having exactly the data required. Mr. Goelz might have substituted "minutes" for "hours" in next to the last paragraph. Maintenance work is such that the engineering corps is called on for little bits of information from all over the division, and it is no unheard-of thing on a branch-line division with meager train service, for a member of the squad to be sent 200 miles and back on a local train to measure the length of plank at a crossing, or the size of a cattle pen. Many of these time-consuming trips are unavoidable, but such data as Mr. Goelz mentions could be kept in systematic fashion for the use of all concerned.—EDITOR.]

Fahrenheit or Centigrade

SIR: The Hon. Albert Johnson of Washington has introduced in Congress a bill to provide for the abandonment of the Fahrenheit thermometer and the use of the Centigrade thermometer by all departments of the U. S. Government. He asks that all scientific and technical men throughout the United States write their Representatives and Senators in Congress as soon as possible and urge that the change be made. He asks also that all the scientific and technical societies pass resolutions to the same effect and send them to the Thermometer Committee, A. A. A. S., Washington, D. C. It is necessary that the work be done promptly and the following history of thermometric scales is given for the information of those who will care to interest themselves in the change from a haphazard, empirical thermometric scale to a sensible and really scientific scale.

The letters and resolutions should ask that the change be accomplished as follows: Any department of the government may adopt the Centigrade scale in its work and publications at any time, but the change shall be compulsory in all departments after Jan. 1, 1920. Until Jan. 1, 1925, the Fahrenheit equivalent shall appear in parenthesis following the Centigrade temperature, but after that date the Centigrade temperature alone shall be used. The Centigrade temperatures are at present those used by scientific men in every country of the world, and are used in the physics and chemistry classes in all high schools and colleges. The change therefore will merely apply to common usage.

Beginning about the year 1680 the literature of science became international, and common measures and weights were seen to be desirable. In 1793 the French government adopted the metric system of weights and measures, this system now being that of scientific men used as the official system in practically every country except those where the English language is the language of the people. With the metric system of weights and measures the French adopted the scale of Celsius for thermometers, naming it the Centigrade, because of the decimal division of the scale.

Gabriel Daniel Fahrenheit, a native of Danzig, in Germany, long a resident of Holland and England, attempted to make a temperature recorder, and first sought for a zero point. He made a saturated solution of salt and placed it in a sealed glass tube containing alcohol. This he succeeded in freezing during the winter of 1709, on the day of the coldest recorded temperature in Holland. After marking the top of the alcohol in the tube the instrument was warmed in the hands of several persons and the highest average point reached by the liquid was taken as normal blood heat and marked 100, the scale being graduated uniformly between those points and continued considerably higher. It was discovered that at very low temperatures and at very high temperatures the expansion and contraction of alcohol was not uniform. It was discovered also that the specific gravity of the liquid was important, so that thermometers made by different men did not agree. Fahrenheit was an instrument-maker and a careful experimenter, so he went about the discovery of a better liquid in a careful, painstaking manner.

About 1714 he learned that mercury expanded uniformly at practically all temperatures, and constructed a bulb thermometer containing mercury. Setting it in a mixture cooled to the zero of his alcohol thermometer, he carefully measured the volume of the mercury and found it contained 11,124 units. Raising the temperature to that of melting ice the volume increased to 11,156 units, an increase of 32, which he marked as freezing point. Placing the tube in water which was brought to a boil the volume increased to 11,336 units, a further increase of 180, making a total of 212, which graduation was then representative of the temperature of boiling water. Being a prominent member of the Royal Society of Great Britain, that society in 1720 succeeded in securing the adoption of the Fahrenheit scale by the British government.

René Antoine Ferchault de Reaumur, a native of La Rochelle, in France, long resident in Paris, believed the arbitrary zero of Fahrenheit was clumsy and unscientific and difficult of restoration, so adopted as his zero the freezing point of water. He used spirits of wine of such a specific gravity that a volume of 1000 parts at the freezing point of water expanded to 1080 parts when the water boiled. His scale therefore was graduated into 80 parts between the freezing and boiling points of water. It is in fairly common use in parts of Russia, Germany and Spain to-day, although the scientific men and manufacturers in those countries use the Centigrade thermometer, and this latter is the official government scale. The Reaumur thermometer appeared in 1731, eleven years after the adoption of the Fahrenheit scale by England.

In 1742 Anders Celsius, professor of astronomy at Upsala University, Sweden, constructed a thermometer in which the freezing point of water, frost point, was zero, following the example of Reaumur. The boiling point of water, however, he fixed at 100, hence the name Centigrade later applied to his thermometer, which is yet called the Celsius thermometer in some countries. Any experimenter may determine the freezing point of pure water and also the boiling point. Any hollow tube with uniform bore may be used, and any liquid may be used which expands at a practically uniform rate. It is thus easily possible to reproduce thermometers in case standards are lost. The graduations are larger than those on the Fahrenheit scale, which is a convenience. To hold to the Fahrenheit thermometer based on unscientific empirical measurements is not creditable to an intelligent people, and as the Centigrade thermometer is in universal use it is time all English speaking countries fall in line with other countries and adopt a universal designation of temperature. Intercourse with other nations will be facilitated and conversion tables will be done away with. The present way of mentioning temperatures, with three thermometers in use, is prolific of mistakes.

ERNEST MCCULLOUGH,
Consulting Engineer.

Chicago.

Decimals of the Degree and of the Full Circle

SIR: Taking note of Professor Jordan's suggestion published in the Engineering Record of Jan. 22, page 121, about having one vernier of the regular engineer's and surveyor's transit to read to minutes and the opposite vernier to decimals of a degree, we desire to call attention to the fact that we have upon request graduated our verniers this way for many years.

Having a transit with two different verniers to the horizontal circle, the A vernier reading to minutes and the B vernier to decimals of a degree, necessitates the use of only one of these verniers at a time. If the engineer wishes to triangulate and use both verniers in reading angles, then both should be graduated alike. In a large engineering center it would be well to have an instrument having the one vernier reading to minutes and the other to decimals of a degree, but when the engineer desires to repeat the same angle on both verniers, this would be confusing. It is not for the instrument-maker to attempt to force the use of the instrument with different reading verniers upon the engineering profession, because the latter will buy what it wants, and it takes many years to introduce a matter of this kind. Moreover, it is of vital importance to the engineer whether he is to use the instrument for construction work or for triangulation.

Boston. C. L. BERGER & SONS.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

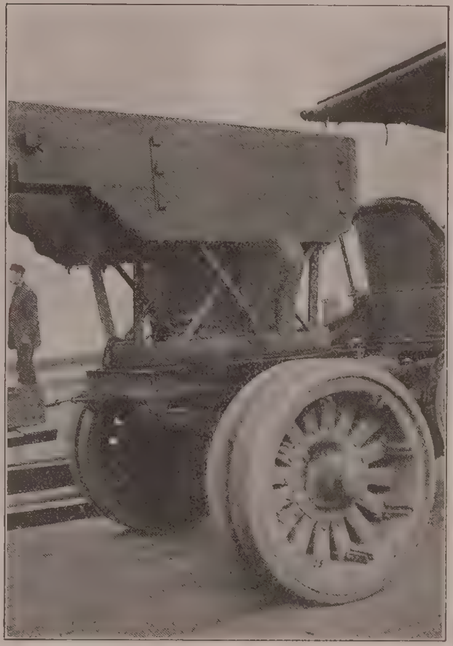
Swing Tractor Truck Developed for Hauling Steel

THE swing tractor truck shown in the accompanying photographs is more than earning its bread and butter in New York City for the Goodman Contracting Company in hauling building, elevated, and subway steel. A motor truck should be kept in a garage at night, while it can be seen that if the truck shown in the illustrations were taken into an ordinary garage there would be no room left for anything else. This consideration has delayed the application of motor haulage to long structural steel members, as the swing truck is much more economical for handling them than any other type, and as, to be effective, the truck must be nearly as long as the members handled.

The difficulty is overcome in this case by making the trailer so it can be released from the tractor in two or three minutes, and left in the yard while the tractor is taken into the garage. The rear of the latter and the front of the trailer are fitted with a rim-bearing center-pin turntable. A bolt engaging a slot in the center pin holds the trailer in place. It is withdrawn with a lever, which is locked in place, while the truck is running, by a pin. At night in the yard a jack is set under the front of the trailer, which is raised until the pin clears the tractor. The tractor is then driven off and a light horse placed under the front end of the trailer for the night. In the morning the process is reversed.

The swing truck is considered greatly superior to the platform truck for hauling heavy steel, as it does not have to wait at either end for a derrick to load and unload. It can take up and drop its own loads in a few minutes. Moreover, the large diameter of its wheels gives a distinct advantage in the reduction of impact and also of the traction required on rough streets.

The ordinary ratchet wheels and shafts, mounted on sliding carriages, are used with a timber lever to raise and lower the loads. This requires at least one man at each end to help the driver, who is the only man needed to travel with the truck. Plans are now being made to apply power to these shafts, so that fewer men will be required to handle the loads. The truck was made by Patrick Goodman, using a Knox tractor and the back parts of two horse-drawn swing trucks. One of these is 45 and the other 60 ft. long, and either is used with the tractor, depending on the length of load to be hauled. Loads up to 15 tons can be carried on either trailer. They are adjusted by sliding the shaft carriages so that about one-third of the load comes on the tractor and two-thirds on the rear truck of the trailer. The deepest girder that can be hauled is 6 ft. 6 in., laid flat. Mr. Goodman states that this truck makes a considerable saving over horse-drawn swing trucks, as it is much easier to handle and can make many more trips per day. Recently it has been climbing with ease the steep grade from the Ninety-sixth Street dock in New York City to West End Avenue with 8- and 10-ton loads of apartment-house steel.



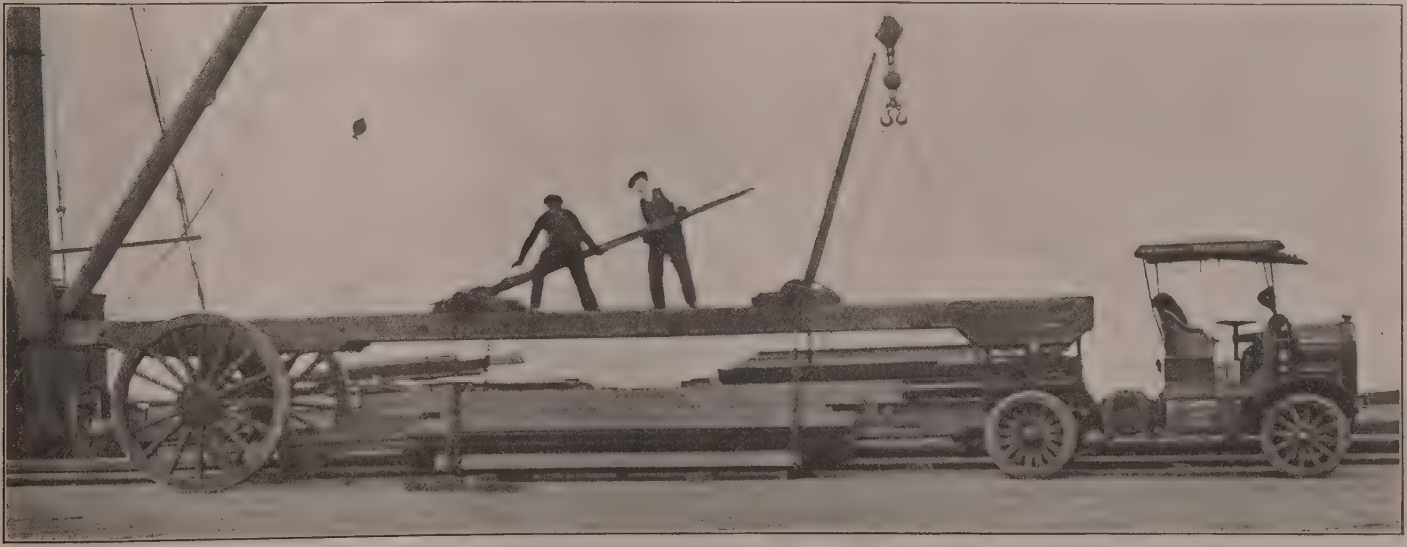
TRAILER IS TAKEN OFF AT NIGHT

Lever under tractor frame at left withdraws the key that locks the center pin of the turntable, when trailer is uncoupled and left in yard at night.

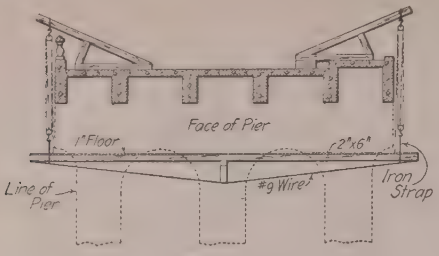
Light Swinging Scaffold Aids Finishing of Underside of Viaduct

By R. C. HARDMAN
Colorado Springs, Col.

THE specifications for a reinforced-concrete viaduct called for a brush finish on all exposed surfaces, except the roadway. Through a rigid interpretation on the part of an inexperienced inspector the washing of the underside of the superstructure was required, as well as of all surfaces visible in horizontal projections. Had the interpretation been made earlier the washing could have been done from scaffolds placed on the falsework before its removal, which was done in the case of the last four spans. However, for the most of the work some other means was necessary, and a swinging scaffold was devised from which practically the entire structure was washed. The scaffold consisted of a light platform suspended at each end from small booms which traveled along the roadway of the structure. Its important details are shown in the accompanying sketch. The swinging platform was built of 2 x 6-in. framework trussed by a king post and several strands of No. 9 wire. The booms were also of light construction so as to be easily moved, counterweights being used to give stability. In use the platform was swung at the bottom of a pier and raised vertically along its face



TRACTOR HANDLES BIG SWING TRUCK MUCH MORE EASILY THAN CAN BE DONE WITH HORSES, AND MAKES QUICKER TRIPS



TRAVELING SCAFFOLD USED ON VIADUCT

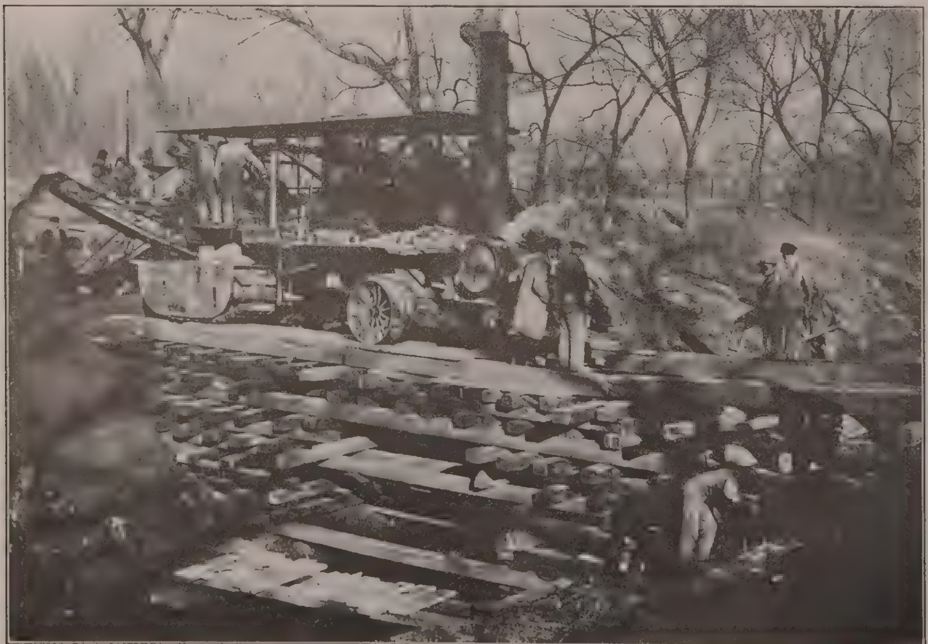
as the washing progressed. When the top of the pier was reached the lines were made fast and the booms moved along, carrying the platform under the span to the next pier, the under surfaces being washed during the movement. The platform was then lowered down the base of the next pier, unhooked, carried around the pier, and a start made on the next span. The ends of the piers were brushed from ladders and the rails from the roadway.

Camp Cooks' Salaries Dependent on Good Meals

GOOD camps and wholesome food were considered vital by O. Laurgaard, project engineer of the Tumalo development, and in order to secure them a sliding scale of wages for the cooks was adopted which raised their pay with the class of meals served and the cleanliness of their establishments. In the final report to the Desert Land Board of the state of Oregon on the construction of this project, it is brought out that great rivalry was developed between the fourteen camps maintained as to which should have the best name with the workmen. A limit of 25 cents a meal, the price charged the men, was set on the cooks, and when the final costs were compiled the camps showed a profit of about 10 per cent. The entire cost of food, transportation, help, utensils, buildings and depreciation was charged to the cost of meals. The profit was due to the premium put on thrift, and to economical management. One-fourth of it is directly accounted for by the practice of supplying young live pigs to each camp to consume the waste from the tables, and later using the pigs for food. With the sliding scale of wages used, making the cook's pay dependent on the quality of his meals, his cleanliness and his economy, it was found possible to secure and hold first-class camp help. This was considered a big factor in the good showing made. It is also stated that the influence of proper food and surroundings on the class of men secured and on their working efficiency constituted the chief profit derived by the state from these camps. The camps were also a large factor in advertising the development and giving it a good name with the public, as large numbers of visitors who might become or might influence settlers were entertained from time to time at the different mess halls.

Crossing an Unbridged Stream with a Trenching Machine

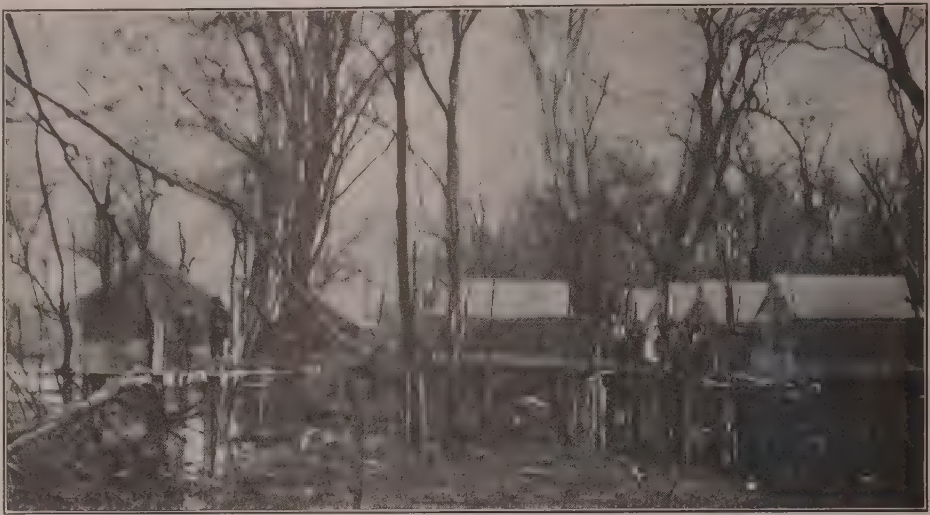
A SEWER contractor in Topeka, Kan., used the cribbing fully shown in the accompanying photograph to get his Austin trenching machine across a small stream. The trench met the stream at right angles, and the cribbing shown not only enabled the machine to cross the stream, but also made it possible to excavate the trench almost to the water's edge, leaving little hand work to be done.



TRENCHING MACHINE MOVES OVER STREAM TO DIG DITCH INTO IT, SAVING HAND WORK

Contractor's Camp on Stilts Made by Cutting Off Natural Trees

THE NATURAL growth of trees was cut off at high water, floored and used to mount the tent camp shown in the accompanying photograph by the contractor for a 9-mile section of levee in southeast Missouri. This section of levee, costing $300,000 and requiring 2,225,000 cu. yd. of fill, is part of a 27-mile dike to be built on the west bank of the Mississippi River for protecting bottom lands of considerable extent. The river had never been confined before at this point, and means had to be found for establishing a camp near the work and yet out of reach of floods. The density of the timber growth, which had mostly been cleared when this photograph was taken, can be appreciated when it is said that only a few piles had to be driven to support occasional corners of the tent floors that failed to fall at a standing tree. The river is shown at 5-ft. stage in the view. The contractor for the levee is the Oglesby Construction Company.

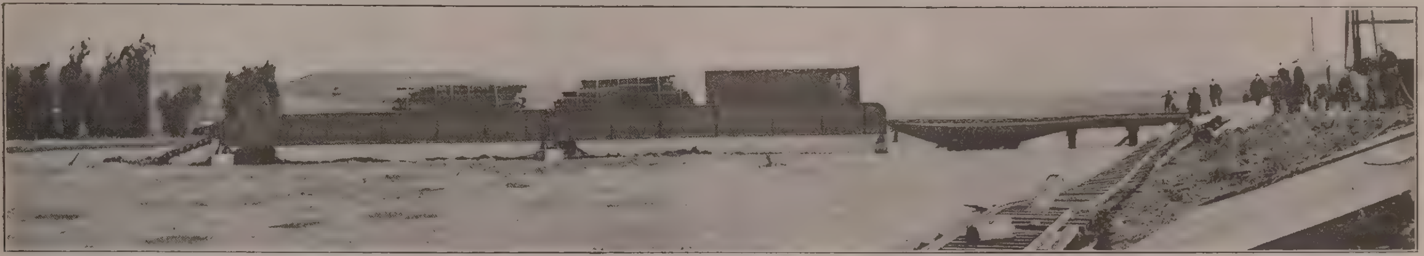


TREES FURNISHED ALL BUT A FEW POSTS FOR PUTTING THIS CAMP ABOVE RIVER'S REACH

THE PURITY OF WELL WATER at Sacramento, Cal., was recently made the subject of an investigation by the Commission of Health and Safety of that city. A bacteria count of more than 100 bacteria per cubic centimeter was reported in only nine wells out of a total of thirty-seven examined in the city and suburbs. Five of these nine showed a count of less than 200. The high counts were in each case from surface wells or from well water sampled after passing into a tank. The report is regarded as indicating the purity of the well supply in this district, where most of the wells tap underground streams fed from the snow-capped Sierra Nevada Mountains. Practically all of the large business houses and hotels in Sacramento are supplied from private wells, and it is asserted that a well system put in by the city would give much more satisfactory results than the present system, under which water is drawn from the Sacramento River, filtered and treated with chlorine to make it sterile.

California Floods Wreck Otay Rock-Fill Dam

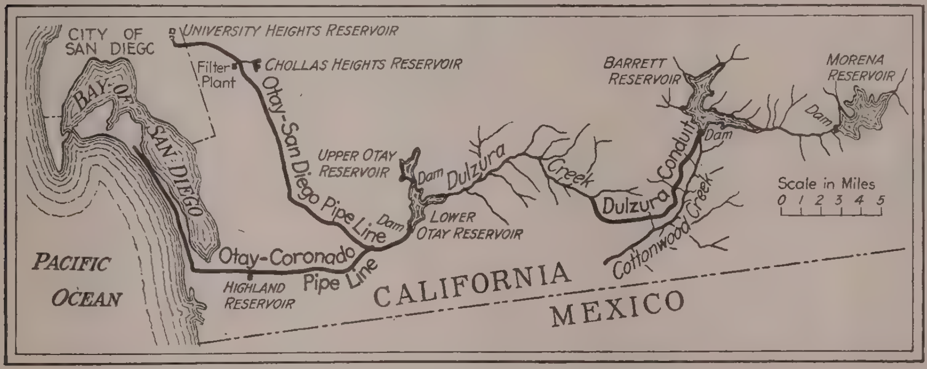
Four Other Dams Withstand Crest Floods—Sweetwater Structure Damaged—San Diego Bridge Washed Out—Water Supply Conduit Injured—Unprecedented Rainfall Deluges San Diego County



SAN DIEGO RIVER BRIDGE WAS PARTIALLY SAVED BY WEIGHTING GIRDER SPANS WITH HEAVILY LOADED CARS, ALTHOUGH FLOOD WATER RIPPED OUT TIMBER TRESTLE SECTIONS AT ENDS

CULMINATING in the complete destruction of the Lower Otay rock-fill dam, with its steel plate core-wall, partial breakage of the Sweetwater masonry dam, over which the water surged to a 3½-ft. depth, washouts of sections of the Dulzura conduit from the Morena dam, and demolition of a new reinforced-concrete highway bridge, unprecedented floods, caused by a record rainfall on saturated drainage areas, swept over San Diego County, California, late last month, leaving a wake of wreckage. A railroad bridge over the San Diego River was partially saved by weighting it down with loaded box cars.

The southern part of the state was visited generally by the storms, but the greatest damage was caused by the fall of rain which reached its maximum in the vicinity of San Diego on Jan. 26 and 27. Rain gage records show the precipitation at San Diego for the season up to Jan. 27 to have been 14.56 in., which is about 5½ in. greater than the usual annual rainfall at this point. It is believed, however, that the excess above normal in the upper part of the drainage areas was much heavier than this. At some points the excessive precipitation came as a warm rain on snow-covered areas, adding the melted snow to the runoff.



SAN DIEGO'S WATER SYSTEM, SHOWING LOCATIONS OF FLOOD-SWEPT DAMS

SAN DIEGO RIVER SWOLLEN

The flow of the San Diego River, as registered at its mouth, increased from 2000 sec.-ft. on Jan. 26 to 29,800 sec.-ft. 24 hr. later. The tributary drainage area is 434 sq. miles, and in this basin the average rainfall varies from 9 in. at sea level to a maximum of 62½ in. in the mountains near the divide. This extreme flow in the river entirely wrecked the $25,000 reinforced concrete bridge which was completed for the city of San Diego about a year ago.

The highway bridge was supported on concrete piers which, in turn, rested on 30-ft. wooden piles whose tops were about 3 ft. below mean low tide level. It is believed that the failure of the structure was caused by extremely deep scouring around the middle pier foundation. Two days before the failure it is reported that a settlement of the floor above the center pier was noted. The approaches to the bridge were solid fills, the entire flow of the stream being confined to the channel beneath the arches.

The railroad bridge across the San Diego River near the same point did not suffer serious loss, as the steel girder spans and the concrete piers on which they are supported remain intact, only the pile approaches being washed out. Foreseeing the flood, the railroad officials left on the structure the three loaded cars shown in the picture to provide additional stability.

SWEETWATER DAM OVERTOPPED 3 FEET

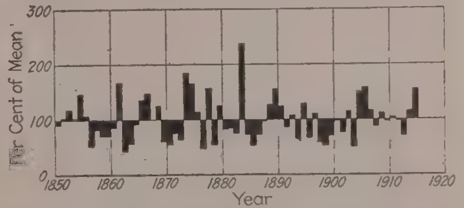
At the Sweetwater dam (details of the design and last height increase are given in an article on page 264 of the Engineering Record of Sept. 2, 1911, written by James B. Schuyler) the recent flood was six times as great as in the average winter flow, or more than twice the flood of 1895, which was the maximum on record up to that time. At the peak of the 1895 flood the flow was 17,000 sec.-ft. and in that season the total runoff from the 100-sq. mile drainage area was 73,000 acre-ft. The flow during the recent storm is calculated by engineers who were at the dam to have averaged about 33,000 sec.-ft. for 4 hr. during the peak of the flood.

The storms which began on Jan. 15 and lasted about four days filled the Sweetwater reservoir up to the spillway level. Before the second storm commenced the two 24-in. and the two 30-in. blow-off valves through the dam were opened to lower the reservoir as much as possible before additional water could come in. These valves, owing to being slightly loose, were opened only half way, thus giving a total flow of about 750 sec.-ft.

On Jan. 27 the flow into the reservoir exceeded the combined capacity of spillway and blow-off valves, and the level behind the dam raised until the parapet was overtopped at 2.20 p. m. At 4.30 p. m. the flow over the parapet had increased to a depth of 3.5 ft., and the 50-ft. length of earth fill dike at the north end of the structure was overtopped. The water washed away this fill, broke the concrete core wall and cut a bypass around the dam through the bedrock foundation. As shown in the accompanying photograph, the break is about 75 ft. wide with a maximum depth of 30 ft. below the level of parapet.

This break was made by degrees, no water appearing below the dike until it was actually overtopped, and the cutting into the foundation was gradual. At 7 p. m. the reservoir level had lowered only 0.3 ft. Water flowed over the parapet about 7 hr. after the break occurred, it is believed, which would mean that the flood continued to overtop the dam for about 9 hr.

An earthen dike 650 ft. long stood some distance from the dam, where a low point in the ridge occurred. This dike had a puddled clay core and was 23 ft. high at its mid-point. At 3.50 p. m. on the day of the flood peak, the water level reached the top of this dike and began to spill over the downstream slope. This melted as the water continued to rise, and when the flood subsided the dike had been swept out cleanly except for about 10 ft. of its length. The material on which the dike stood was eroded by the outpouring water to such an extent that the reservoir rim at this point is now 15 ft. below the spillway level.



VARIATION IN SEASONAL PRECIPITATION FOR SAN DIEGO COUNTY EXPRESSED AS PERCENTAGE OF MEAN

Reconstruction plans contemplate a hollow type reinforced concrete dam at the site of the earthen dike, and at the north end of the main dam where the break occurred an additional spillway. Other than these two breaks and the section of pipe line washed out immediately below the dam, no further damage was suffered at this point. John F. Covert, consulting engineer for the Sweetwater Water Company, was at the dam during the peak of the flood and supplied the foregoing data.

WHILE MORENA DAM STOOD UP THE ROCK FILL SETTLED ABOUT 3 INCHES AS SHOWN BY DARK LINE AT RIGHT OF PICTURE

LOWER OTAY DAM SWEPT OUT

The Lower Otay dam was a rock filled structure 130 ft. high and 565 ft. long on top, which spanned the Otay Creek 22 miles southeast of San Diego. It was built by the Southern California Mountain Water Company to impound a water supply for San Diego and Coronado, and after a construction period of several years was completed in 1897.

The slopes were 1 to 1 on both up and down stream faces and no attempt was made to make the upstream face impervious, reliance being placed in the central core. As shown in the accompanying drawing, the steel core was founded in a block of concrete, and was protected from foundation to crest by 1 ft. of concrete on either side. The steel plates were ⅜ in. thick near the base and ⅝ in. near the top. The plates were 5 x 20 ft. in size. The joints were calked. The fill was, at least in part, blasted into place from the adjacent walls of the canyon.

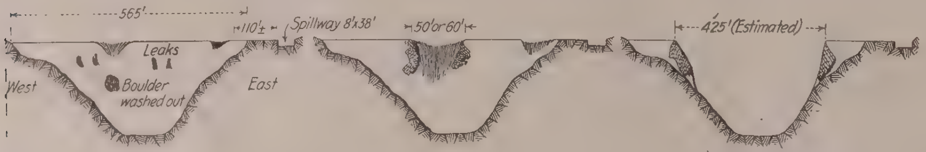
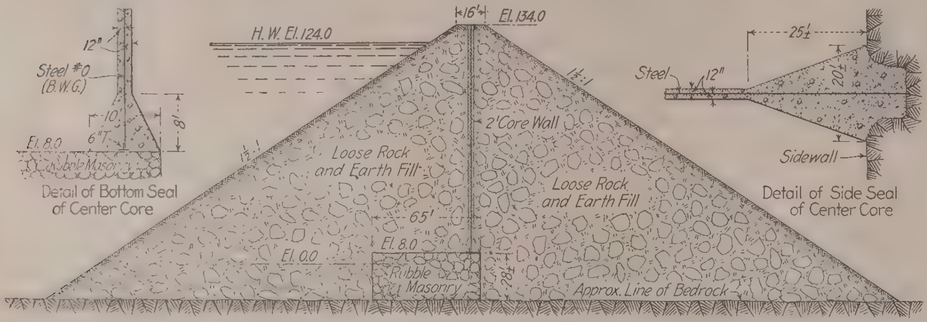


FIG. 1—4^{45} P.M. FIG. 2—5^{05} P.M. FIG. 3—RESERVOIR EMPTY

SUCCESSIVE STAGES IN FAILURE OF LOWER OTAY DAM, FROM EYE-WITNESS DESCRIPTION



CROSS-SECTION OF LOWER OTAY DAM

LOWER OTAY ROCK-FILL DAM, WHICH FAILED, HAD 1:1 SLOPES AND A COREWALL OF STEEL PLATE ENVELOPED IN CONCRETE

The spillway is a concrete-lined conduit whose location can be traced high up on the right of one of the accompanying photographs, and has a throat section of 8 x 37.9 ft. The drainage area was 100 sq. miles, including the 20-sq. mile drainage supplying the Upper Otay dam, which is located on the same stream.

This structure was acquired by San Diego in 1913 as part of the water supply properties purchased by the city from the Spreckles interests, the price paid for the Lower Otay dam, conduits, water rights, and the Barrett dam site was $2,500,000, and a later bond issue of $1,500,000 was voted and used to purchase the Morena dam and reservoir.

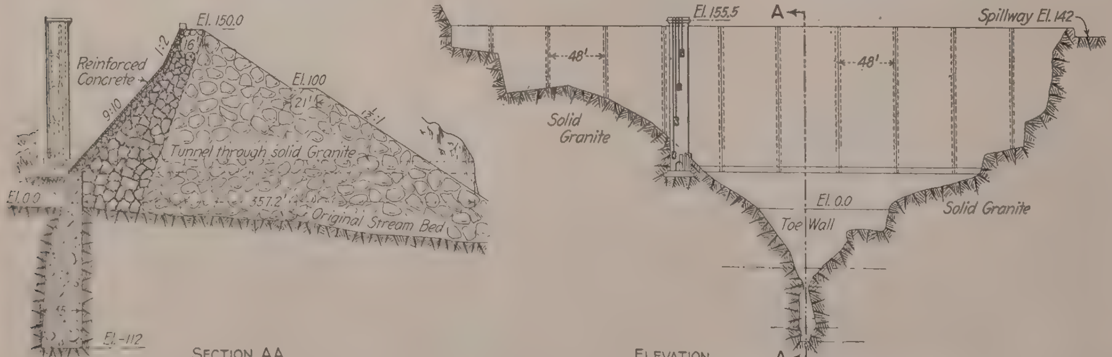
OTAY RESERVOIR FILLS QUICKLY

The excessive rain caused a sudden inflow into the Otay reservoir which filled it in less than a week, the rise continuing to be rapid even after the higher levels of the 13,000,000,000-gal. reservoir were reached. The first 17-ft. rise came in 48 hr., leaving the level on Jan. 17 at 101 ft. After that date the water level changed as follows: Jan. 18, 111 ft.; Jan. 19, 118.7 ft.; Jan. 21, 122.8 ft. (spillway level); Jan. 27, 7 a. m., 124.9 ft.; Jan. 27, 12 noon, 127.9 ft. (48-in. gate through dam opened); Jan. 27, 4.45 p. m., 130.8 ft., at which level failure occurred.

Failure did not commence until the water had overtopped the 5-ft. earth dike surmounting the core wall, but witnesses agree that the depth of the overflow before failure was very slight, probably between 4 and 6 in. The first failure occurred at the top near the center and at about the same time the water commenced to pour out of the downstream face in considerable volume, and one large boulder, an eye-witness asserts, was washed out near the middle of the structure. The accompanying sketches show how the failure progressed. There is no indication that the structure slipped along its foundation or that there were excessive leaks or blow-outs before overtopping occurred.

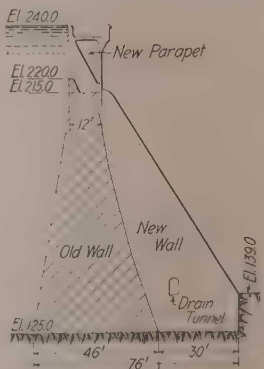
An examination of the steel core exposed after the failure showed that the metal was in perfect condition, although it had been in service 20 years. Investigation of the records, however, showed that it had been very carefully given a protective coating during construction. This consisted of a coat of hot asphalt, followed by a burlap covering, and over the burlap a second asphalt coating was applied. Numbers of rivets from the steel core which had been sheared in two were found below the dam.

While the reservoir level was still 4½ ft. below the crest, the city attorney of San Diego called a conference with the mayor,



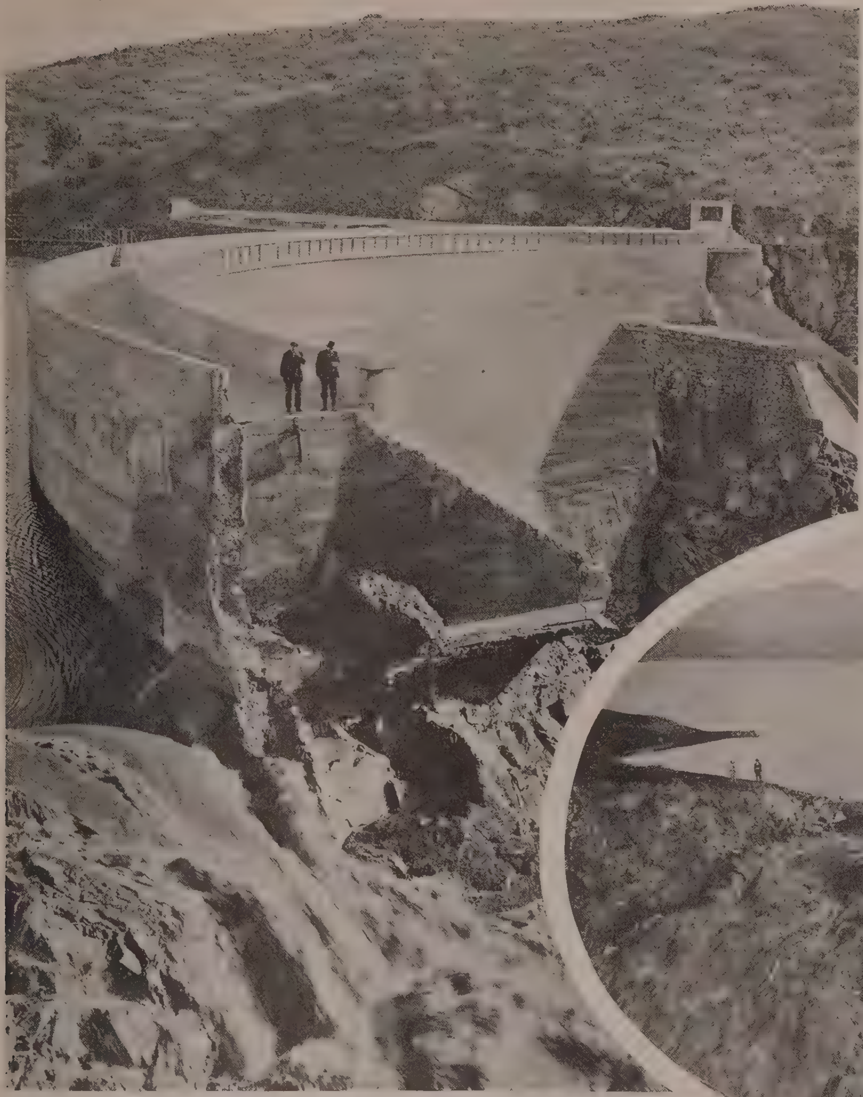
SECTION AA ELEVATION

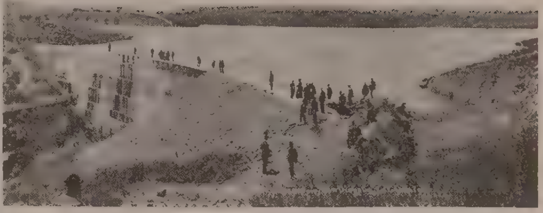
MORENA ROCK-FILL DAM, ALMOST OVERTOPPED, HELD DURING HIGH WATER STAGE



SWEETWATER DAM SECTION

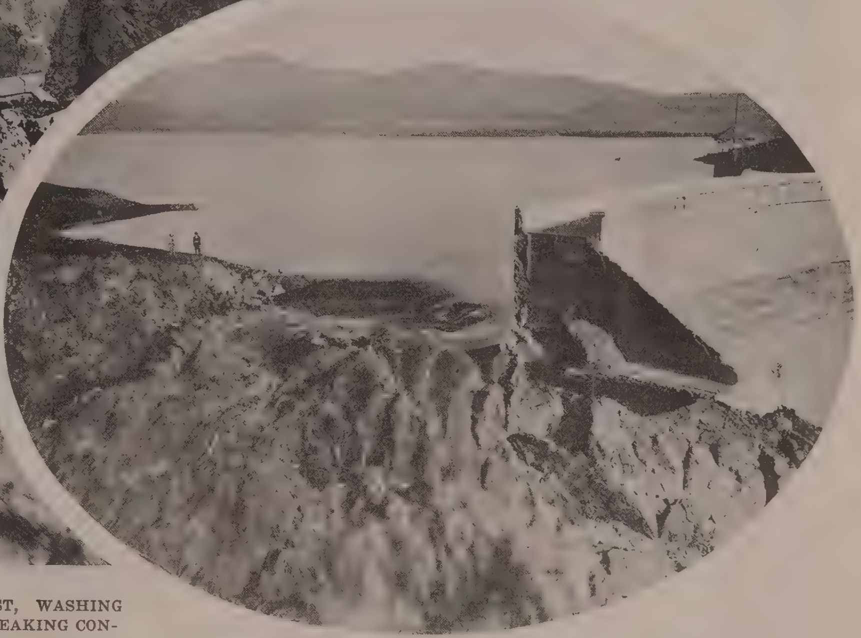
Flood's Damage to Dams in San Diego County Section



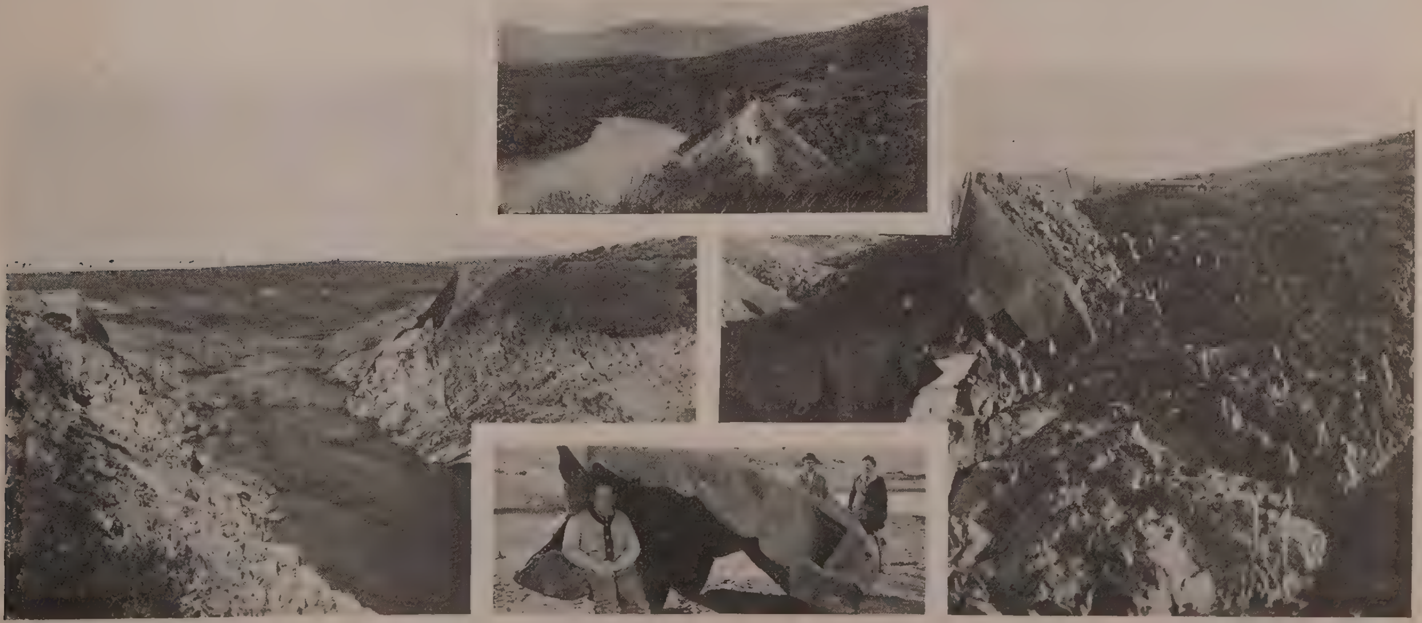


UPPER OTAY ARCHED REINFORCED-CONCRETE DAM WITHSTOOD FLOODS WHICH PASSED 3 FEET DEEP OVER ITS CREST. SAND BAGS RUSHED TO SITE PREVENTED OVERFLOW AT EARTH FILL NEAR END

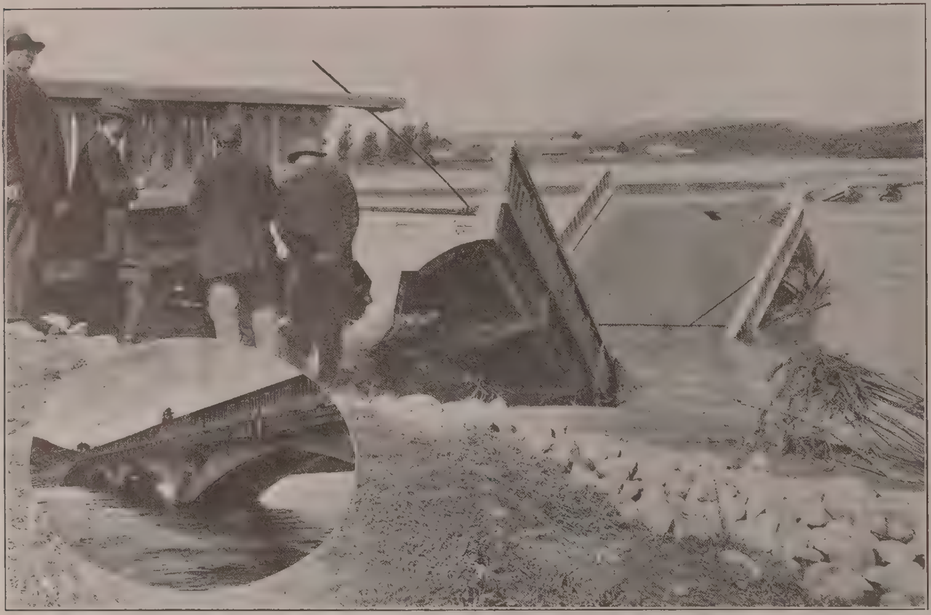
AT THE SWEETWATER DAM WATER OVERTOPPED THE CREST, WASHING AWAY A 50-FOOT LENGTH OF EARTH FILL AT NORTH END, BREAKING CONCRETE CORE WALL AND CUTTING A BY-PASS AROUND DAM THROUGH BEDROCK FOUNDATION



THE BREAK IS 75 FEET WIDE WITH MAXIMUM DEPTH OF 30 FEET BELOW LEVEL OF PARAPET



LOWER OTAY DAM, A ROCK-FILL STRUCTURE WITH STEEL PLATE CORE-WALL, WAS COMPLETELY DEMOLISHED. SMALL PICTURE, TOP CENTER, SHOWS STRUCTURE BEFORE FAILURE. LOWER INSERT SHOWS STEEL PLATE CORE WALL SECTION CARRIED 10 MILES DOWN STREAM. PICTURE AT LEFT INDICATES BREACH AFTER WASHOUT AND AT RIGHT A BENT SECTION OF CORE WALL STILL HANGING IN PLACE city manager, and the city engineer to discuss the danger of the situation. It was not believed that the dam would go out, but it was recognized that the danger point was reached. Accordingly the city dispatched four men to warn residents of the valley below the dam to go to higher ground. Two of these men went down the valley on either side, leaving the dam at 2 p. m. on the day of its failure, and warned all residents that the only safe procedure would be to leave the valley until the reservoir level was lowered. These men traversed the entire valley before the dam broke, and those who were drowned, in almost every case, had disregarded the warning.



REINFORCED-CONCRETE BRIDGE AT SAN DIEGO RIVER WAS UNDERMINED AT PIERS AND WASHED OUT

The effective height of the tidal wave sweeping down the valley is shown by the denuded area on the canyon wall just below the dam. No authentic statement could be secured as to the height of this wave in the lower sections of the valley, but it may at least be said that its force was sufficient to sweep everything before it. All houses and other structures in the valley bottom were swept downstream and strewn along the bank or carried out into the bay. The loss of life as first reported was erroneous, and on Feb. 3 the coroner affirmed that the actual number of known dead was only 14.

Morena Dam Almost Overtopped

The Morena dam, located on Cottonwood Creek 35 miles southeast of San Diego, is a rock fill structure 150 ft. high with a concrete face on the upstream side. The drainage area above this dam is 135 sq. miles and the reservoir capacity is 15,000,000,000 gal. The runoff from this basin was such that 15,000 acre-ft. was added to the storage in 24 hr. This addition took place while the 60-ft. spillway was running 5 ft. deep.

The flood brought into the reservoir a large quantity of debris which accumulated in front of the racks that protect the radial gates, and so choked the flow that when the reservoir level was 3 ft. above the spillway level the flow actually passing over the spillway beneath the open gates was only 3 in. deep. Under these conditions the water rose within 18 in. of the parapet crest and waves actually carried debris over the top.

Two effects of this pressure are apparent. A downstream movement of the upper face of the dam which showed in the alignment of the parapet as about 2 or 3 in. at the center of the structure, and a settlement of the top of the rock fill amounting to 2 or 3 in. The amount of leakage could not be observed, but George Cromwell, city engineer of San Diego, who was at the dam during the high water, affirmed that he believed such leakage as there was came through the face of the structure and not around the ends or from beneath. Leakage some time prior to recent storms amounted to 1,500,000 gal. per day.

After going down to the bottom of the intake tower during the height of the flood, Mr. Cromwell reported that structure was standing the pressure well, only slight seepage appearing. The intake gates were all in working order and all were left open to lower the reservoir level as much as possible. The debris was being removed by as large a force of men as could be readily assembled. Orders to lower the reservoir 3 ft. below the spillway level by means of the intake gates were left at the dam.

Conduit Damaged

Dulzura conduit, the 13.3-mile line which conveys the water stored behind the Morena dam into the Otay system, washed out in several places. The damage to this conduit line, Mr. Cromwell estimates at about $85,000, or about 12 per cent of its original cost. The rain gage at Dulzura Summit showed a precipitation for the storm of 9.9 in., but it is believed that in some districts traversed by this conduit the actual fall was near 12 in.

Certain portions of the conduit stood the storm much better than others; in some cases it bridged a span of 4 or 5 ft. over washouts. These more stable portions differed from the remainder in that the flume was built in 16-ft. lengths with "settlement joints" intervening. At each of these joints a yoke of concrete 4 x 8 in. in section and which had been cast and seasoned in a yard, was first placed in the trench as a support for the concrete flume proper, and a transverse steel tie rod was used which spanned the flume and bound yoke and flume walls together. The width of the conduit is 5 ft. at the top and 3 ft. 3 in. at the bottom; the depth is 3 ft., and the walls are 4 in. thick. Reinforcing was used only between floor and walls. The "settlement joints" were devised by H. A. Whitney, former hydraulic engineer of San Diego.

Upper Otay Dam Holds

The Upper Otay reservoir, which provides an auxiliary storage above the dam that failed, has a drainage area of 20 sq. miles and a storage capacity of 1,090,000,000 gal. This reservoir is formed by an arched, reinforced-concrete dam 84 ft. high, built on a radius of 358 ft. The section has a base thickness of 14 ft., reduced by steps to only 4 ft. at the top for 5 ft. below the crest. The reinforcing consists of 1-in. steel cables, two of which were imbedded in the concrete for every 18-in. rise. The cost of this dam, which was built in 1897-1901, was $28,000.

The rainfall on the Upper Otay basin is thought to have been among the heaviest in the district. The reservoir level rose very rapidly and at the peak of the flood the flow over the entire length of the dam crest was 3 ft. deep. No damage whatever was done at this point. Judicious use of sand bags, however, prevented overflowing near an earth fill at one end and, it is thought, prevented difficulty from a washout at this point.

Cuyamaca Earth-Fill Dam Has Close Call

The Cuyamaca earth-fill dam with a puddled core, built in 1886 for irrigation uses, is located 50 miles east of San Diego at an elevation of 4800 ft., and is on the headwaters of the San Diego River basin. Its crest is 635 ft. long and its height 41.5 ft. Two spillways are provided, 90 and 41 ft. long respectively, and each 6.5 ft. below the crest of the dam. The storage capacity is 10,800 acre-ft.

The impending danger of the recent flood was realized in time to draw down the Cuyamaca reservoir considerably. In fact the amount drawn off by the blow-off valve through the dam was about 1,000,000,000 gal. The peak of the flood brought the reservoir level up to within 14 in. of the crest of the dam with both spillways flowing over 4 ft. deep. A few washouts on the conduit constituted the only damage suffered by this system, which includes, in addition to the Cuyamaca dam, three smaller reservoirs on tributaries of the San Diego River. At the present time the San Diego water supply is being drawn from the Cuyamaca system.

Speaking Ability of the Young Engineers in the corps of the Milwaukee Sewerage Commission is being developed by staff meetings held every two weeks, at which engineering news of the week, commission problems, knotty designs and other matters of interest are discussed. At first, it is said, the rodmen and lower paid men were diffident about talking. Now they take an active part and are not afraid to present their views "before the chief." The effect on the staff in creating interest and loyalty, in addition to the development of latent ability, is beyond expectations, according to T. Chalkley Hatton, chief engineer, who is of the opinion that heads of departments owe it to young engineers under them to afford them some such opportunity.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

First Train Crosses New Cumberland Valley Bridge

The first train to cross the new Cumberland Valley Railroad bridge over the Susquehanna River at Harrisburg, Pa., was passed Feb. 4. A few minutes later President Wilson's special from the West where he had just completed his speaking tour, passed over the viaduct.

The bridge is being built by the Cumberland Valley Railroad, as part of a general scheme of improvement in Harrisburg, approximating in cost about $3,000,000. The bridge itself will cost about $1,000,000.

The work on the concrete portions is being done by the Robert Grayce Company of Pittsburgh. The first half of the bridge from shore to shore was completed a short time ago, and on Feb. 3 the track work was completed. Work on the second half will start about April 1. It will be a 3-track structure when finished.

PART OF NEW RAILROAD BRIDGE AT HARRISBURG COMPLETED AND IN OPERATION FEB. 4

Urge House of Representatives to Provide Officer Reserve Corps

Representatives of five national engineering societies appeared before the House of Representatives military committee Feb. 8 to advocate the provision of an officers' reserve corps, with a view to utilizing the services of civil, electrical, mechanical and mining engineers, and others having technical knowledge.

Cleveland Freight Subway Likely to Be Started This Spring

Announcement is made by the promoters of the proposed 7-mile four-track subway under East Fifty-fifth Street, in Cleveland, from Lake Erie to the upper river valley that they will ask the city council for certain modifications in their franchise, and that if these are granted the work will be started this spring. The franchise amendments aim at better interchange facilities with the connecting railroads, and the avoidance of a vein of quicksand near Euclid Avenue.

The present franchise, which was approved by popular vote last election day, stipulates that 4 miles of double-track subway must be completed and in operation in five years from Nov. 3, 1915, and the remaining 3 miles within seven years. Work must begin by Nov. 3, 1917, on both the subway and the bulkheads along the lake.

The estimated cost is $10,000,000. The promoters are O. C. Barber, of Barberton, Ohio, and J. J. Breitinger. H. D. Goulder, Rockefeller Building, is attorney for the company.

Break in Sooke Lake Waterworks System Caused by Landslide

Twelve lengths of pipe were swept away and considerable water wasted owing to a break in the concrete flow line of the Sooke Lake waterworks system Jan. 22. This is the first accident which has occurred to the line. It was caused by a landslide. The damage is slight, it is reported, and until repairs can be made a temporary wooden trestle bearing a wooden flume will be used. The water stored in the Humpmack reservoir is reported to be more than sufficient to supply the city while repairs are being made.

Chicago Traction Experts Begin Work Feb. 14

The ordinance confirming the appointment of the Chicago traction commissioners has become a law, and the new commissioners, William Barclay Parsons, Robert Ridgway and Bion J. Arnold, have planned to take up the work of investigating Chicago's transportation problem Feb. 14, with a view to making early recommendations for improvements. Mr. Parsons was named chairman of the commission in the ordinance authorizing its appointment.

May Discard Tunnel Scheme in New Britain Water Project

Test drilling at Burlington, Conn., for the New Britain Water Department has thus far failed to find rock through which a tunnel for a new pipe line into the city could be built. At a depth of 80 ft. no rock has been found. Four more drills 110 ft. in depth will be made over a mile distance. If no rock is discovered the tunnel scheme will be abandoned.

Indiana Engineers and Sanitarians Celebrate Centennial of Endeavors

More Engineers for the State Board of Health, More Pay for County Surveyors and a Highway Commission Recommended

Indiana county surveyors can draw only $4 per day and expenses, yet many of them are called upon to handle work costing as much as $400,000. The Indiana Engineering Society, which met Feb. 3, 4 and 5 in conjunction with the Indiana Sanitary and Water Supply Association, urged the necessity of a concerted effort toward legislation whereby engineers holding such positions may be paid more nearly in proportion to the responsibilities involved.

The high lights at the convention, aside from a number of historical papers summing up sanitary and engineering progress in Indiana since that State entered the union 100 years ago, were as follows: a paper on activated sludge, by T. Chalkley Hatton, chief engineer Milwaukee Sewerage Commission; one on the reasons for forcing efficiency onto utility plants, by Charles Brossmann, consulting engineer; the phenomenal results obtained by the Logansport sanitary survey, described by H. E. Barnard, State food and drug commissioner; advertising as applied to public utilities, by Merle Sidener, and a plea for a readjustment of the standards for gravel to be used in concrete, by C. C. Brown.

Filter Experts Object to Throwing Out Air Wash

Philip Burgess, in his paper outlining the present status of rapid water purification, suggested as a future step the retention of excess chemical sludge in reaction chambers, and agitation with the incoming water. This is now practised successfully at Owensboro, Ky.

The discussion hinged on the washing methods. H. O. Garman, chief engineer of the Public Service Commission, stated that in his opinion an air wash was of no value, that he had therefore refused to allow any value for it in appraisals and that he had advised filter operators not to use the air. To this attitude several prominent sanitary engineers strenuously objected. Definite instances were cited of plants where only low vertical rises of wash water are possible and where the air keeps the sand clean which would otherwise fill up with mud balls.

Water superintendents will want to read carefully the results of tests on lead service pipes reported by Prof. R. B. Wiley, Purdue University.

Following a paper by John C. Diggs describing four new filter plants in Indiana—Logansport, Princeton, Paoli and Wolcott—came a discussion as to the reasons why a city the size of Logansport had to be treated to repeated epidemics of twenty to thirty deaths each before filter construction could be finally consummated. Compliments were also paid to city officials who put well designed plants into the hands of incompetent operators.

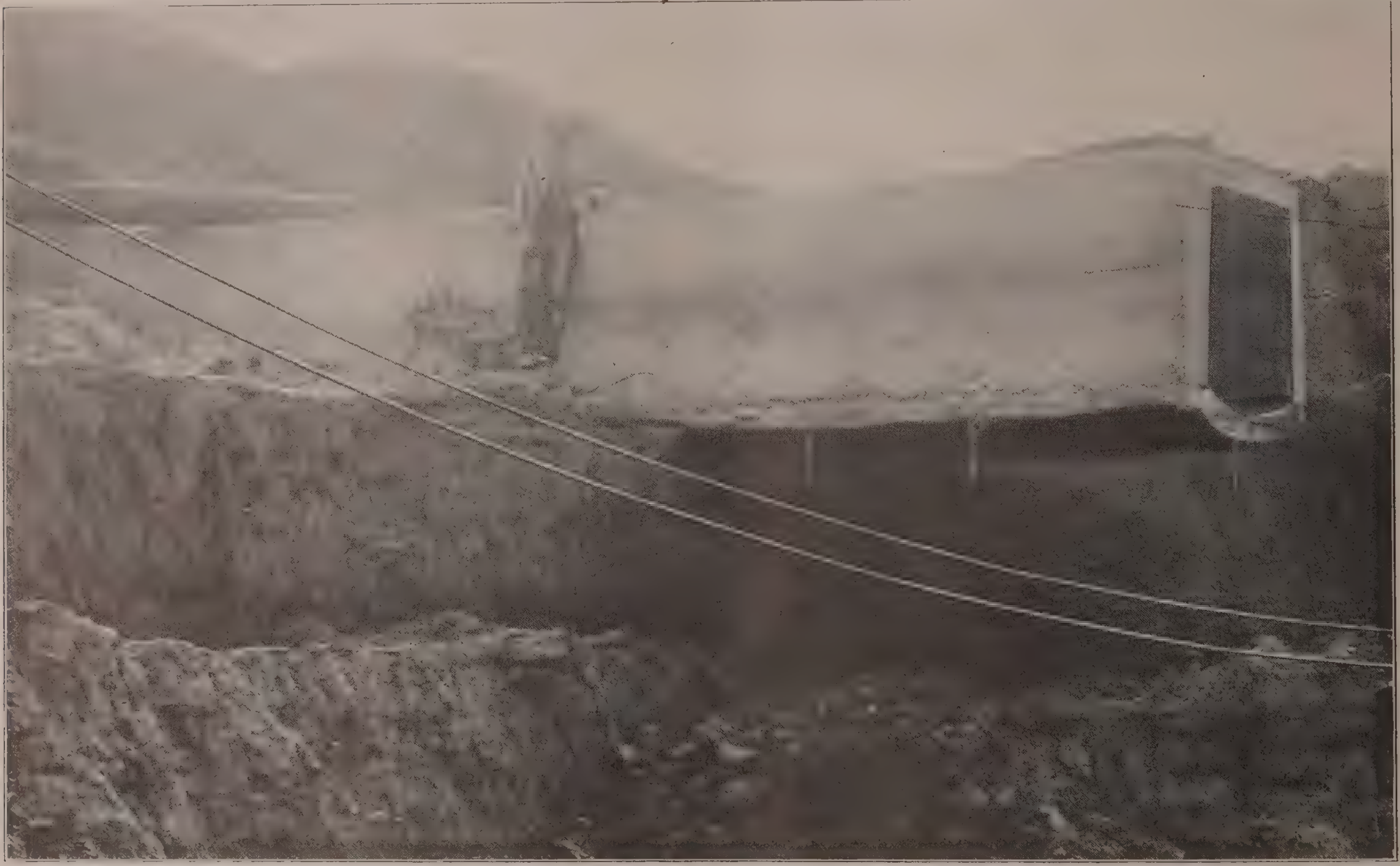
C. K. Calvert, chemist, Indianapolis Water Company, read a paper on the increase of oxygen content in reservoirs due to oscillaria. No remedies were proposed except in after-meeting discussions. W. F. Langelier was of the opinion that the incoming water might in some way be subjected to pressures less than atmospheric with beneficial results.

Activated Sludge Progress

Of the ten experimental plants working on activated sludge during the past ten months all but one or two report good results, according to Mr. Hatton, who stated also that the Milwaukee Sewerage Commission had just recently accepted tentative plans for a plant to treat 100,000,000 gal. daily. The cost will be $18,000 per 1,000,000 gal., a figure he considered high, because of the necessity of building a portion of the plant out in the lake.

The Phister & Vogel Company, leather manufacturers, have authorized the construction of a plant and, on the basis of an experimental tank, expect to recover values netting $30,000 annually.

One of the largest meat-packing establishments in Chicago, said Mr. Hatton, is of the opinion that $1,300 per day can be recovered from wastes now being thrown away. Mr. Hatton was very careful, however, to be conservative and to point out that the extremely clear non putrescent effluent from this treatment was entirely unnecessary to obtain in many cases.



SECTION OF CONCRETE CULVERT WITHOUT LONGITUDINAL REINFORCEMENT DOES NOT COLLAPSE WHEN UNDERMINED

Structure at Memphis, Tenn., 4 x 4 ft., without longitudinal reinforcement, had ground give away under it for a distance of 14 ft., and remained intact for two weeks, when it broke off near the band. The proportions of the concrete were 1:2½:5.

H. B. Hommon, chemist, U. S. Public Health Service, recited his experiences with strawboard wastes during the past year. Rapid filters were a failure, but Imhoff tanks followed by cinder filters for the sludge seemed to offer the most promising solution. Use of the dried sludge on farm land also appears to be fairly successful, but elaborate experiments on all kinds of crops are to be undertaken this year.

In discussing the subject Paul Hansen stated that sanitarians were waiting anxiously for the final results. If any fertilizing values are available which will help out the various companies, many stream pollution problems will be immediately simplified.

Efficiency Forced on Utilities

Competition, the price of material, the desire for lower rates and state regulation are all forcing utilities to be more efficient, according to a paper on the subject by Charles Brossmann. His paper was full of things about the inefficient pumping station equipment, such as feedwater heaters out of service, leaky boiler settings, clogged condensers, dampers connected backward and pipe changes.

W. E. Graves, city engineer, South Bend, presented in his paper data on the behavior of concrete sewer pipes, some of which were laid in 1874.

Prof. U. S. Hanna gave detailed information on fine cracks in a two-course reinforced-concrete road 25 ft. wide laid eighteen months ago through the campus of Indiana University. The causes of the cracks were, in his opinion: Insufficient lap of the reinforcing, improper treatment of subgrade and lack of drainage.

C. C. Brown, in his paper on "Standardization of Gravel for Concrete," brought up the contentions of the Indiana Sand & Gravel Association, viz., that to specify sand as material passing a ¼-in. mesh was an unnecessary refinement. Analyses show that there is a preponderance of fine material in many of the bank and river gravels of the state, but tests indicate that good concrete can be made with the material. The gravel companies want the specification changed to define sand as that portion passing a ⅛-in. screen. Tests corroborating these contentions are to be made at Purdue University.

Society Affairs

The engineering society passed a resolution lending the influence of the organization toward obtaining state supervision of highways.

For the ensuing year the following officers were elected: President, Prof. L. W. Wallace; vice-president, J. W. Miller; trustees, J. C. Toyne and J. W. Moore.

The sanitary and waterworks association elected E. L. Loomis, president; W. S. Cramer, Dr. J. N. Hurty, R. B. Wiley, P. Burgess and J. B. Marvin, vice-presidents; W. F. King, secretary, and W. S. Ulrich, assistant secretary.

The association adopted a resolution urging legislation permitting full-time health offices and a force of sanitary engineers under the State Board of Health to pass on all plans for water supply and sewage-disposal plants.

District Court Decides Against Bone Cantilever Wall Patent

Regardless of the fact that several other courts decided in favor of the plaintiff in similar suits, Judge A. B. Anderson of the United States District Court of Indiana, found for the defendant in the suit brought by Frank A. Bone of Cincinnati, Ohio, against the Marion (Ind.) county commissioners for alleged infringement of patent in reinforced-concrete walls used in the construction of bridges. The amount involved was estimated at $30,000 and, had the case gone in favor of the plaintiff, the City of Indianapolis also would have been a defendant in a suit for half that amount. Judge Anderson's decision, which was verbal, was handed down on Jan. 26. He said:

"In reviewing the evidence in this case, I find no cause whatsoever to lead me to believe that there has been an infringement on patent; further, I do not believe the patents as claimed by the plaintiff are valid. This court finds for the defendant with all costs to be paid by the plaintiff."

Prominent architects and engineers of Indianapolis and Indiana, as well as D. B. Luten, F. A. Bone and E. B. Bone, testified for the plaintiff, but the testimony that apparently carried the greatest weight with the court was submitted by Prof. W. K. Hatt, of Purdue University. He stated that in view of the newly discovered evidence of prior use and patents, the Bone patent was not infringed in the construction of the retaining walls in Marion County, the witness citing the following five authorities: Stowell & Cunningham, United States Patents; Bauzeitung; Rehbein; Nolthenius in Tjidschrift, and Planat's Articles, Vols. 9 and 11, La Construction Moderne.

Testimony submitted by the plaintiff went to show that Bone claimed to have patents on all reinforced cantilever retaining walls, Bone adding to this claim by stating that he had won fifty similar suits in various counties in various states throughout the United States, that he had many similar suits pending in other courts and that five judges already had decided in his favor. Testimony was submitted to the effect that Bone's contention had been upheld by Judge Day, of Columbus, Ohio; the United States Circuit Court of Appeals, sixth district, Cincinnati, Ohio, and by Judge Trieber, of Denver, Col. It is understood that the case will be appealed.

Contractor Must Pay Workmen's Compensation on Percentage Contract

A contractor employed on a percentage basis to wreck and rebuild the plant of an owner coming under the Michigan workmen's compensation law sought to make the owner pay compensation for an injury to a workman engaged on the undertaking, claiming that he acted only as the owner's agent or superintendent, and that his workmen were in reality employees of the owner. The state industrial accident board refused to allow the claim, holding that the contractor was an employer within the meaning of the law as regarded that particular contract, and, as such, was required to stand his own workmen's compensation liabilities. The contractor carried liability insurance for the job, and the surety company was held liable for the damages.

White River Levee Breaks at Clarendon, Arkansas

The White River levee at Clarendon, Ark., broke on the evening of Feb. 5 and the water covered two-thirds of Lincoln, Desna and Chicot counties in southeast Arkansas. Water is also flowing through several breaks in the Arkansas River levees. Arkansas City and dozens of smaller towns are flooded. In the former water is running 8 ft. deep in the main streets, and the waterworks and electric light plants are out of commission. At last reports the Mississippi River levees were still holding, although at Arkansas City the flood stage was 55½ ft., the highest, it is said, ever known at this place.

Los Angeles County Sanitation Commission Named

The Los Angeles County Board of Supervisors on Jan. 24 announced the personnel of the commission of sanitary engineers who are to devise a comprehensive plan for sewage disposal throughout the county. The commission is composed of Prof. Charles Gilman Hyde, of the University of California, T. A. Gillespie, of the State Board of Health, A. H. Koebig, George R. Robinson and A. M. Brosius. The supervisors have appropriated $1,000 for the use of the commission.

Submit Report on Building Districts and Limits for New York

The commission on building districts and restrictions appointed by the Board of Estimate of New York City to consider and report on a districting plan for the puropes of regulating the height of buildings, the area of courts and yards, and the location of trades and industries has just issued a progress statement of its plans and filed detailed maps showing the suggested districts and proposed limitations. If the report of the commission is adopted by the Board of Estimate after public hearings, it will become law.

The commission desires thorough study of the proposed plans, and urges property owners and civic organizations to inspect the proposed district maps with reference to their particular localities, so that mistakes can be avoided and the proposed maps perfected before submitting them to the Board of Estimate. Edward M. Barrett is chairman of the commission and Robert H. Whitten is secretary. George B. Ford is consultant to the commission, which has in its membership representatives of the real estate and civic interests of the city.

Young Engineer to Head Big Traction Property

Philip J. Kealy, civil engineer, not quite 32 years old, has been selected to head the Kansas City Railways Company, a $30,000,000 corporation which on Feb. 14 will take over the ownership of the 263-mile electric railway system serving Kansas City. He will be, as the *Electric Railway Journal*, the leading paper in the traction field, states, the youngest president in the United States of so extensive a street-railway property.

Mr. Kealy's election comes as the logical sequence of traction events at Kansas City, where for the past three years he has been in the thick of the controversy over renewal of the traction franchise. As engineering adviser to the receivers of the present owners, the Metropolitan Street Railway Company, he bore a leading part in the negotiations which resulted in the drafting of the Kealy-Ash plan, under which the property is to be operated by a board of control consisting of two men, one representing the city and one the company. Under this plan, after making up certain amounts definitely specified, the city is to share in the company's net profits. A new ordinance embodying this plan was adopted, and since it went into effect Mr. Kealy has been the company's member of the board of control. It is understood that he will retain this position while discharging the duties of the presidency of the company.

Civil Engineer Becomes President of Large Electric Railway Property

PHILIP J. KEALY

Mr. Kealy was born in Bloomington, Ill., July 2, 1884, and spent two years in the civil engineering course at the University of Illinois. For six months he was engaged in railway work in Mexico, and then entered the electric railway field. His first employment in this line was with the Board of Supervising Engineers, Chicago Traction, on the rehabilitation of the city's electric railway system. This work brought him in touch with Bion J. Arnold, who, recognizing Mr. Kealy's ability, gave him a place on his (Mr. Arnold's) staff. As assistant to Mr. Arnold he had charge of electric-railway valuation work in Seattle, Buffalo, Chicago and Toronto. In 1912 this work took him to Kansas City, and after completing the valuation there for Mr. Arnold, he was temporarily "loaned" by the latter to the traction company. The work in hand was so arduous and complicated and required so much time that the company induced Mr. Arnold to release Mr. Kealy, so that he might devote himself entirely to the Kansas City work. His handling of that situation, with bitter opposition to the proposed plan from influential newspapers, his courage in taking the stump to put the proposition before the citizens, made him a marked man in Kansas City. The sheer merit of the plan, backed up by his forceful presentation of it, resulted in its adoption by a goodly majority.

In addition to his work at Kansas City, Mr. Kealy has during recent years acted as consulting engineer on various valuation work in Missouri and neighboring states.

Declare Removal of Boston Engineers Blow to Efficiency

Seven prominent civil engineers—Frederic P. Stearns, Desmond Fitzgerald, H. F. Bryant, Charles T. Main, Harrison P. Eddy, Frank A. Barbour and Edward C. Sherman—in a statement issued Feb. 4 in regard to the recent wholesale removal of engineers in important offices in the Boston public works department, characterized the mayor's action as striking a "disastrous blow," which not only affects most seriously the present efficiency of the department, but will, unless it is counteracted, lower the standard of efficiency to a still greater extent in the future.

In the opinion of the signers, the public should be made to realize the seriousness of the situation that has been created. "Hitherto," the statement continues, "civil engineers have entered the city's employ in the lower grades, knowing that as they developed in skill and efficiency, and rendered valuable service to the city they not only would be protected in their position but would have a chance to advance as opportunity offered.

"This practice has brought to the service of the city, and retained in it for many years, engineers who were both trustworthy and qualified for their work, but the recent action of Mayor Curley in removing, without just cause, men who have given loyal service for a long term of years, means not only that competent engineers will refuse to enter the service of the city in the future, but that those still in the service will be anxious to leave as soon as opportunity offers for other employment."

May Change Terms of Apportionment for Street Improvements

Alfred Bavis, president of the Board of Public Works of Richmond, Ind., is considering the adoption of a new rule for the payment of the city's share for permanent street improvements that may result in a change of the state's laws in regard to such payment. As explained by Mr. Bavis:

"For years the city has merely designated the amount of money it will contribute toward the cost of a permanent street improvement. In consequence, if the successful bid were lower than the estimated cost, the city did not benefit from the reduction in the expense, although the property owners did. We now are considering the advisability of merely designating what per cent of the cost of an improvement the city will be willing to assume. There is a question, however, as to whether this can be done under the laws of Indiana, as they now stand. A former city attorney ruled that the city had to designate the amount of money it would contribute."

Highway Official Must Have License to Operate Car in Pennsylvania

Deputy Attorney General Keller of Pennsylvania decided in an opinion recently rendered that a state highway engineer or superintendent must take out a driver's license to operate an automobile.

Not Ready to Predict Date for Re-Opening Panama Canal

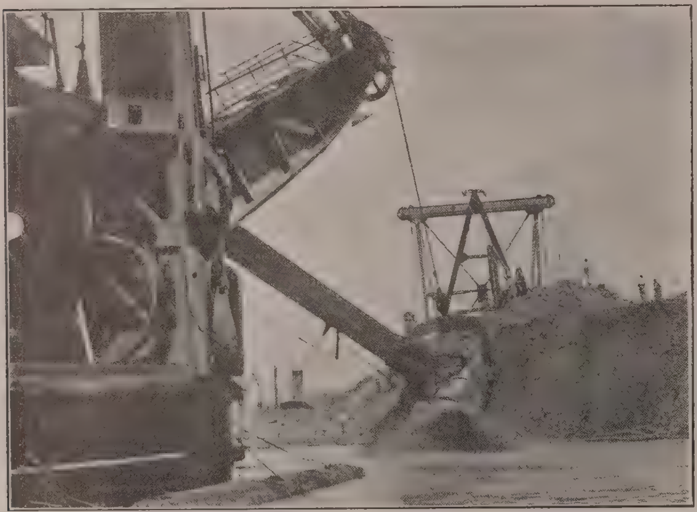
No prediction can yet be made, according to Governor Goethals, as to the date for re-opening the Panama Canal. It is hoped, however, that information regarding two controlling features will soon be available, after which a prediction will be made. A recent statement from Governor Goethals reads as follows:

"It is not intended to re-open the canal until a safe and practicable permanent channel is reasonably assured. This cannot be assured at present, although the operations of the dredges during the past four months have shown that they are able, when not interrupted in the work by the passage of ships, or the clearing of the channel for navigation, to gain on the slides, and it is desired to have a reasonable assurance that they can maintain this gain even with the delay from the above causes.

"It is hoped that before long better information on the two main controlling features will be available. The large mass of rock at the base of Gold Hill, on the east bank, is being carefully observed. If the materials behind it move northwardly, as is not unlikely, one danger of interruption to navigation will be removed.

"The other feature is the rate of motion that will result in the west slide when the dredges attack its face, as will shortly be done. It is believed that the dredges can keep well ahead of any possible motion in this mass, provided the east bank is quiescent or nearly so.

→ STEEL DREDGE CASCADE AT WORK IN CULEBRA CUT



← CUTTING AWAY SLIDE-FORMED ISLAND IN PANAMA CANAL

"As soon as this office feels that sufficient information on these two points is at hand to justify it, a prediction will be made. In the meantime, it is recommended that the canal be not considered in the routing of shipping. The work of the restoration of the canal is, however, proceding most favorably. The office has in mind the desire of commerce to resume navigation through the canal, and as long notice as possible will be given to shippers in order that preparations for such routing may be adequate."

The last ship waiting at the canal was passed through Jan. 6, states the *Canal Record*. The ship was the "Newton." It had been waiting since Oct. 15, 1915.

The *Canal Record* also states that 232,292 cu. yd. of excavation were handled during the week ended Jan. 10.

Owner of Team Hired by Contractor Liable for Injury

The State Industrial Board of Indiana has decided that a driver, supplied by the owner of a team, is the employee of the owner of the team, and not of the person or company contracting for the team. This decision establishes a precedent for the industrial board. The driver of a wagon, whose owner held a contract with an asphalt company, was injured in a railroad accident. With the board holding that the asphalt company is not responsible, the widow must look to the owner of the team for compensation or sue the railroad.

Form New Sewage Works Association in Jersey

To advance the knowledge of design, construction, operation and management of sewage treatment works the New Jersey Sewage Works Association was organized at a meeting in Trenton, Jan. 28. Clyde Potts, consulting engineer and member of the State Department of Health, was the chief organizer of the movement. The constitution admits to membership in the new association superintendents, managers or other officers of municipal or private sewage works, civil, hydraulic or sanitary engineers, chemists, bacteriologists, or any persons engaged in the design, construction, operation or supervision of sewage works or engaged in the manufacturing or sale of sewage works equipment. The admission fee is $1 and the annual dues $1. Membership applications may be addressed to Frederick T. Parker, secretary, Atlantic City Sewerage Company, Atlantic City, N. J.

A regular annual meeting of the association is to be held at the State House, Trenton, at the same time as the annual conference between the state department and local boards of health. Special meetings will be held at such times and places as arranged by the committee.

The following officers were elected: President, John R. Downes, Plainfield, N. J.; vice-presidents, Paul Molitor, Chatham, N. J., and I. D. Collings, Collingwood; secretary-treasurer, Frederick T. Parker, Atlantic City.

Will Begin Cheektowaga Grade Separation Near Buffalo Soon

The beginning of work on the Cheektowaga grade separation in Erie County, New York, this spring was made sure at a final hearing in the matter before the Public Service Commission at Albany, Jan. 29, when agreement among the parties to the elimination was reached on the important details, and some minor matters were submitted to Seymour Van Santvoord, chairman of the commission, for incorporation in an order to be drawn as soon as possible. Representative of the Delaware, Lackawanna & Western Railroad assured the commission that they would start work as soon as the order was made.

This is one of the most important single grade-crossing eliminations in the State. It will cost in the neighborhood of $400,000, and will take two years to complete. When completed the roadway will be carried on a 30-ft. viaduct over fifty-seven tracks of the Delaware, Lackawanna & Western, three of the Lehigh Valley and two of the Erie. The viaduct will be more than 3000 ft. long, and the plans include an elaborate system of drainage and of marginal streets and other adjacent improvements.

Overhead Transfer System to Be Built at Mobile Waterfront

The Terminal Transfer & Storage Warehouse Company, of Mobile, Ala., reorganized in December, proposes to construct a system of elevated railways or overhead conductors between its extensive warehouse properties there and the waterfront. The system is to include elevators at each end to permit the lifting of electrically-propelled tractors or trucks to the level of the overhead system at one end, and the lowering of the carriers to the ground level at the other end. There are also to be installed devices for distribution, where needed, to operate over a number of streets on which the warehouses are situated. The plant of this company covers approximately 22 acres in the northern part of the downtown section of Mobile.

The structural work is to be performed by the Stone & Webster Engineering Corporation, of Boston. Moores & Dunford, of Chicago, architects and promoters, designed the preliminary details. The first work will comprise the building of a large warehouse alongside the slip in the Hieronymus property, with dock and electric apparatus for hoisting cargoes from and into vessels, the contract for which has already been let.

As soon as the attorneys have passed upon the title of the lands recently purchased by the company, bonds to the amount of $1,000,000 will be issued. It is stated that work of building the plant will start within six weeks.

California Railroad Commission Sustained in Utility Valuation

The Supreme Court of California handed down a decision on Jan. 17 sustaining the ruling of the State Railroad Commission in the valuation of properties of the Marin Water & Power Company. This is the first case in which the Supreme Court has passed upon the validity of the act under which the commission has proceeded to fix the value of public utility properties in eminent domain proceedings. The court decision is of importance in that this case is parallel to numerous others which the commission is now or will be considering, namely, the valuation of the Southern California Edison Company properties and the water cases instituted by the cities of San Diego and Santa Monica.

The Marin municipal water district asked the commission to fix the just compensation to be paid to the Marin Water & Power Company for the latter's property. When the commission fixed this valuation at $1,200,000 the power company appealed to the court to overthrow the decision, first on the claim that the commission had no authority, and second that the valuation fixed was too low, depriving it of property without due process of law. The commission's order was upheld in every particular by the court.

Full Enrollment for Military Lectures Requires Overflow Meeting

The widespread response to the call for enrollment in the military lecture course to begin at the United Engineering Societies Building in New York next Monday evening has made it necessary for the committee to limit the attendance to 1600, which is the maximum number which can be provided for. Tickets, which the committee is now sending to those who signed for the course, will be required for admission to the auditorium. The overflow from the auditorium will be taken care of in a second lecture hall on the fifth floor where one of the regular lectures will be given by an army officer scheduled to speak at a later meeting in the main auditorium.

Thacher Patent on Concrete Bridges Upheld

The United States Circuit Court of Appeals for the fourth circuit, sitting at Richmond, Va., on Feb. 2 affirmed the decision of the lower court in favor of Edwin Thacher in the case of Thacher vs. the Mayor and City Council of Baltimore, an action brought on account of alleged infringement by the city of the Thacher patent on concrete bridges. The decree of the lower court is confirmed on the reasoning advanced by that court in its opinion.

Illinois Counties Agitate Bond Issue

The success of Cook County in getting the $2,000,000 road bond issue validated by the Illinois Legislature last week has spurred on each of the four counties adjoining Cook County to agitate the issue of $1,500,000 bonds. The supervisors of these counties have already voted to put the proposition up to the people at the next available election.

Excavation on the Rochester Sewer Tunnel Almost Complete

About 250 ft. remains to be excavated to complete the 4300-ft. sewer tunnel being built under Main Street, West, Front and Graves Streets in Rochester, N. Y. This tunnel has been driven in Niagara limestone under the center of the streets traversed, necessitating cross cuts from 30 to 50 ft. long to reach the shafts, which were located in cross streets to save interference with traffic. About 2420 ft. of the completed sewer will have an inside diameter of 8 ft., and 1317 ft. will be of 6 ft. diameter, the remaining length being made up by the cross cuts. Its depth below the street varies from 35 to 40 ft. The top of each section is a semi-circle of the diameter given; the bottom is a box section 3 ft. deep for each size. The floor in each case slopes 1 in. per foot toward a small, semi-circular drain at the center. Lateral tunnels 4 x 5 ft. in size are provided from the sewer to within the curb line at intervals on either side to drain the adjacent property. These are now being driven. The sewer will care for the storm water from a large central area in Rochester, and also for the leakage from the river at times of high water into the tailraces at Graves Street.

STARTING DOWN THE SHAFT

A contract for the work was let on April 7 last to M. H. Ripton of Rochester, at $117,715. The work was opened up from six shafts, and is now entirely holed through except for the short section mentioned, which is between shafts 1 and 2. The main compressor plant for running the drills and shaft hoists is set up in Graves Street.

The work was designed and is being supervised by the engineering forces of the city of Rochester, of which Frederick T. Elwood is city engineer. Edwin A. Fisher is consulting engineer for the city and Charles L. Raymond is engineer in charge of the project.

VERTICAL COLUMN DRILL IN HEADING OF SEWER TUNNEL BEING FINISHED AT ROCHESTER

American Association of Engineers Publishes Journal

The American Association of Engineers, established in Chicago last year, has begun the publication of a monthly magazine called "The Monad." A 5 x 8-in. page size has been adopted, and the first issue contains 60 pages. Chief position is given to a report of the proceedings of the first convention, and a statement of the work of the association. There are also local notes, which are sure to be followed with interest by the members.

The rather unusual name of "Monad" has been adopted because the Monad symbol was the first sign used by man to signify progress through co-operation.

News of Engineering Societies

The Iowa State Drainage Association will meet in Fort Dodge Feb. 24 and 25.

The Vermont Society of Engineers will hold its annual meeting at Hotel Vermont, Burlington, March 9.

The American Society of Civil Engineers will hold a meeting in New York City, Feb. 16. A. B. Lueder and W. J. R. Wilson will present a paper on "Secure Subway Supports."

The Engineers' Society of Western Pennsylvania will hear Dr. J. A. L. Waddell, consulting engineer, of Kansas City, on "What Can Best Be Done to Advance the Interests of the Engineering Profession in the United States," at a meeting to be held in Pittsburgh, Feb. 29.

The Florida Drainage Association will hold its annual meeting at Sanford, Feb. 28-29. The question of land reclamation for agricultural and other purposes will be discussed by public men, engineers, contractors, business men, lawyers and scientists. Benjamin Getzoff, secretary-treasurer, of Bartow, is in charge of arrangements.

The Society of Engineers of Eastern New York, at a meeting held in Schenectady, Feb. 2, heard John G. Brady, former Governor of that territory, speak on the "Mineral and Timber Resources of Alaska," and adopted resolutions favoring the immediate preparation of the national defenses with respect both to personnel and material.

The Engineers' Club of Philadelphia will hold a meeting in that city Feb. 15. George McAneny, president of the Board of Aldermen of New York City, will present a paper on "Municipal Problems." The proposed amendments to the by-laws, submitted at the regular meeting of the club, Jan. 18, may be discussed and amended, and then accepted for ballot or rejected.

The New York Section of the American Waterworks Association will hold a meeting at Hotel Manhattan, New York City, Feb. 16. Walter E. Spear will present a paper on "City Tunnel of the Catskill Aqueduct," Joseph Goodman, one on "The Determination of the Value of Fire Protection Afforded by the Queens County Water Company" and Francis F. Longley, one on "Improvements to the Water Supply of St. Johns, Newfoundland."

The Guild Scientific League of the University Settlement of New York City desires as members a number of young men who are interested in mechanics, surveying, engineering and similar subjects. The league has taken up the study and discussion of mechanical problems in a non-technical, informal way, under the leadership of a graduate engineer. The meetings are held in the University Settlement, 184 Eldridge Street, New York City, on Sunday afternoons.

The Western Society of Engineers was addressed Feb. 7 by Richard T. Fox, general manager, Citizens' Street Cleaning Bureau, on "Intensive Street Cleaning Methods." The hydraulic, sanitary and municipal section elected the following officers: Chairman, W. W. DeBerard; vice-chairman, W. T. Barnes; directors, H. E. Hudson and R. M. Yager.

The Connecticut Society of Civil Engineers will hold its annual meeting at New Haven, Feb. 15 and 16.

The Canadian Society of Civil Engineers has elected the following officers for the ensuing year: President, G. H. Duggan, vice-president and general manager, Dominion Bridge Company, Montreal; vice-president, T. H. White, chief engineer, Canadian Northern Railway, Vancouver; councillors, J. R. W. Ambrose, chief engineer, Toronto Terminals Railway Company, Toronto; H. Donkin, deputy minister, Department of Works and Mines, Halifax; A. E. Doucet, Quebec; W. J. Francis, consulting engineer, Montreal; E. D. Lafleur, chief engineer, Department of Public Works of Canada, Ottawa; D. O. Lewis, district engineer, Canadian Northern Railway, Victoria; D. A. Ross, consulting engineer, Winnipeg, and H. R. Safford, chief engineer, Grand Trunk Railway, Montreal.

The Detroit Engineering Society heard Frederic H. Fay, of the firm of Fay, Spofford & Thorndike, consulting engineers, of Boston, on the "Boston Metropolitan District" at a meeting held in that city, Jan. 21. Mr. Fay laid emphasis on the duty of engineers to give themselves to some extent to public service, because so many of the problems of a municipality are of an engineering character. He outlined the work of the committee on municipal and metropolitan affairs of the Boston Chamber of Commerce, of which he is chairman, as displayed in its constructive interest in the larger municipal problems of Boston, in keeping watch of legislation, reporting on public improvements, offering suggestions regarding the solution of important problems, and aiding, with the prestige of the chamber, in putting through measures which appear to be for the public good.

Personal Notes

Major George B. Pillsbury, Corps of Engineers, U. S. A., has been assigned to duty as district engineer officer at Los Angeles, Cal. Major Pillsbury received his professional education at Massachusetts Institute of Technology and the U. S. Military Academy, being commissioned in the engineer corps of the army in 1900. Since that year he has been engaged in the construction of fortifications in this country, road and bridge construction and surveys in the Philippine Islands, and, as engineer member of the Alaska Road Commission, on road and bridge construction in Alaska. From 1908 to 1912 he served as associate professor of mathematics at the U. S. Military Academy. Previous to his present assignment he served as district engineer officer at New London, Conn.

T. Filskov, formerly engineer maintenance of way and structures of the Raritan River Railroad, has been appointed acting superintendent, succeeding C. M. Himmelberger, resigned.

Henry E. Elrod, consulting engineer, of Dallas, Tex., has been retained to investigate the waterworks and electric light plants of Sherman, Tex., for the purpose of increasing their capacities.

Max J. Welch, formerly consulting engineer, of Los Angeles, Cal., has joined the force of the Cerro De Pasco Mining Company in New York City. Mr. Welch has been located on the Pacific Coast for the past ten years, and has been connected with the designing departments of several of the most extensive new plants which have been built in recent years for the milling and smelting of copper ores.

I. A. Cottingham, formerly assistant general manager and engineer maintenance-of-way of the Sunset-Central Lines, has been appointed special engineer in charge of valuation work.

Roy D. Tyler, formerly consulting engineer, of Caspar, Wyo., has been appointed engineer of erection and equipment for Montgomery, Ward & Company. Previous to engaging in consulting practice Mr. Tyler was a division engineer on the Lake Shore & Michigan Southern Railway.

Harrison Gunning, formerly engaged on sewer construction at Ravenna, Ohio, has been appointed to a position on the sanitary engineering forces of the Panama Canal. Mr. Gunning was graduated from Union College in 1914, and was, for a time, with the New York State Department of Health.

H. F. Hartwell, formerly resident engineer for the Northern Contracting Company on work for the Georgia Railway & Power Company at Mathis, Ga., has been appointed resident engineer for the Grand Canyon Power Development Company at Peach Springs, Ariz.

C. E.-A. Winslow has resigned as director of the New York State Division of Public Health Education, to accept the Anna M. R. Lauder professorship in public health at Yale University.

Dr. Matthias Nicoll, Jr., has been appointed director of the New York State Division of Public Health Education, succeeding C. E.-A. Winslow, whose resignation is noted elsewhere in these columns.

F. E. Weymouth has been appointed engineer of construction of the U. S. Reclamation Service, succeeding S. B. Williamson, resigned. Mr. Weymouth has been in the Reclamation Service since its organization in 1902, and, before the reorganization last year, was supervising engineer of the central district. He has many achievements in the service to his credit, the largest of which is the construction of the Arrowrock Dam in Idaho, the highest dam in the world. He was graduated from the University of Maine in 1896, and worked from then until 1897 on sewer construction at Malden, Mass. In the latter year he joined the engineering forces of the Metropolitan Water Board of Massachusetts, remaining in that service until 1899, when he was appointed assistant city engineer of Winnipeg, Man. Later in the year he resigned to accept a position with the Isthmian Canal Commission on surveys and estimates for the proposed canal through Nicaragua. From 1901 to 1902 he was with the Guayaquil & Quito Railway of Ecuador as resident engineer on nine miles of railway construction in the Andes Mountains. He joined the U. S. Reclamation Service in 1902. In 1903, while in charge of investigations in North Dakota, he discovered the reclamation possibility that later materialized into the Lower Yellowstone project. From 1904 to 1908, as project engineer, he had charge of the construction of the canal system on that project, and the starting of work on the Lower Yellowstone Dam. In the latter year he was appointed assistant supervising engineer of the Idaho division, and, in 1910, supervising engineer of that division, in which capacity he had charge of the construction of the dam at Jackson Lake, the canal and drainage systems on the Minidoka project, the canal system on the Boise project and of Arrowrock Dam, which was completed last year.

Thomas F. Williams, formerly chief mechanical engineer of the Aeromarine Plane & Motor Co., of Avondale, N. J., and a specialist in carburization of fuels, has accepted the position of chief consultant of the board of engineering research, mechanical applications, of the Powdered Coal Engineering & Equipment Company, of Chicago, and will direct the research work of that company in the carburization of comminuted fuel, and the application of automatic mechanical regulation and controls thereof.

Robert S. Weston and George A. Sampson have formed a partnership, under the firm name of Weston & Sampson, to engage in engineering practice, at 14 Beacon Street, Boston, where they have been associated for several years. The firm will specialize in water supply and purification, sewerage and sewage disposal, and the disposal of municipal and factory wastes, including the making of investigations and reports, the preparation of plans, contracts and specifications, the supervision of construction, the superintendence of the operation of municipal and private purification plants and the valuation of waterworks and water power. William Wheeler will co-operate with the firm, mainly in an advisory capacity.

Thomas A. Hayden has been transferred from the field division of the U. S. General Land Office to office work in the office of the surveyor general at Phoenix, Ariz. Previous to his connection with the General Land Office, Mr. Hayden was city engineer of Santa Fé, N. M., in which city he had conducted a private engineering practice for ten years.

F. Lavis, consulting engineer, of New York City, has become associated with the American International Corporation in an advisory capacity in regard to railway and general development projects in Central and South America. During the past two years Mr. Lavis has been an earnest advocate of the necessity of co-operation on proper lines of the United States in the development of South and Central America, and, particularly, of the necessity of an intelligent interest in, and financial aid for the development of transportation facilities as the basis of all other development. He was educated in England, but first engaged in engineering work in this country in 1889 as rodman on railroad work in the vicinity of Boston. In 1890 he went to Cuba on work near Santiago. From 1892 to 1894 he was with the Cartagena-Magdalena Railroad in Colombia, and, from 1895 to 1897, he served as transitman and assistant engineer for the New York, New Haven & Hartford Railroad. As locating and resident engineer for the Chihuahua & Pacific Railroad, from 1898 to 1899, he located about seventy miles of railway in Mexico, and had charge of the construction of about thirty miles. Later he engaged in mining work in that country and Arizona. After about two years of service on the Boston & Maine Railroad and the Exeter & Hampton Street Railway, following that work, he was appointed locating engineer of the Choctaw, Oklahoma & Gulf Railroad, in which capacity he had charge of preliminary and location surveys in Oklahoma and the Indian Territory. In 1903 he returned to the New York, New Haven & Hartford as assistant engineer. He left that service later in the year to accept a similar appointment with the New York Central. Later he was with Westinghouse Church Kerr & Company on the Pennsylvania Terminal work in New York City, and with the New York, Westchester & Boston as locating engineer. In 1905 he was appointed resident engineer in charge of the construction of the Bergen Hills tunnels in New Jersey for the Pennsylvania Railroad Company. Following this work he became a member of the engineering firm of Guerber, Lavis & Company, and, in 1910, general manager for the Dominion Construction Company, retaining his connection, however, with the first mentioned firm. In 1912, in addition to his consulting practice in New York City, he assumed the office of chief engineer of the Argentine Railway.

Luther Wagoner, consulting engineer, of San Francisco, has been appointed chief engineer of the Havana sewerage and paving contract by President Menocal of Cuba. Mr. Wagoner has been engaged in engineering since 1866, when he served for a short period as deputy county engineer of Johnson County, Missouri. In 1866 he entered the service of the Union Pacific Railway, in which he remained five years, leaving it to become engineer in the land department of the Texas Pacific. From 1874 to 1877 he was in Brazil on bridge construction, geodetic work and mine development, and, in 1879, he engaged in water supply work in Kansas. In 1884 he had charge of the construction of a section of the San Francisco sea wall. After four years spent in a general mining engineering practice, from 1896 to 1900, he was given charge of the investigations for a new water supply for San Francisco. During the period intervening since then he made the plans for the reclamation of Colusa Basin in California, and also for dams, canal systems, reservoirs and other irrigation works in California, Arizona, New Mexico, Washington and British Columbia, and was consulting engineer for the Modesto and Turlock irrigation districts.

R. D. Goodrich has resigned from the office of city engineer of Cheyenne, Wyo., to become manager of municipal public utilities under the Board of Public Works of Ypsilanti, Mich.

A. N. Johnson, formerly chief engineer of the Illinois Highway Commission and at present on the staff of the New York City Bureau of Municipal Research, will become consulting highway engineer of the Portland Cement Association with headquarters at 111 West Washington Street, Chicago, on or about April 1.

James Adams has been appointed assistant to the city engineer of Binghamton, N. Y.

E. W. Edwards, formerly a partner in the engineering firm of Edwards & Chamberlain, of Eldora, Iowa, has become connected with the force of S. B. Gardner, consulting and drainage engineer, of Benson, Minn.

Angus S. Hibbard, consulting engineer, Bell Telephone Building, Chicago, will hereafter act as consulting engineer for firms or corporations desiring advice in matters pertaining to commercial or technical business organizations in addition to his present work. Mr. Hibbard was general manager for the Chicago Telephone Company for eighteen years and was for eleven years connected with the American Telephone & Telegraph Company.

C. F. Schulz will retire from the office of water commissioner of Cleveland, March 1, when Thomas Farrell, city utilities director, will assume personal charge of the system. Charles P. Jaeger, present deputy commissioner, will remain as Mr. Farrell's chief assistant. Mr. Schulz has been connected with the waterworks department for 34 years, and was chief engineer until four years ago, when he became commissioner.

John Boldt and Albert S. Low, until recently superintendents for the Samuel Austin & Sons Company, have formed the Boldt-Low Construction Company, contractors, with offices in the Swetland Building, Cleveland.

Edward W. Cunningham, formerly assistant building commissioner of the city of Cleveland, has been appointed building commissioner of that city. Mr. Cunningham was graduated from Ohio State University in 1894, and was, for a time, connected with the Osborn Engineering Company, of Cleveland. He was appointed assistant building commissioner 4 years ago.

E. P. Roberts, formerly consulting engineer, of Cleveland, has entered business as a manufacturer's agent with offices in the Hippodrome Building, that city.

William S. Twining, formerly consulting engineer to the Department of City Transit of Philadelphia as the representative of Ford, Bacon & Davis, has been appointed director of that department, succeeding A. Merritt Taylor, by Mayor Smith. Since 1910, when he resigned as chief engineer of the Philadelphia Rapid Transit Company, Mr. Twining has been with Ford, Bacon & Davis, consulting engineers, of New York City; for the last 2½ years as consulting engineer to the department he has been appointed to direct. He was chief engineer of the Philadelphia Rapid Transit Company and of its predecessor, the Union Traction Company of Philadelphia, from the time of the organization of the latter company, in 1895, until 1910. Under his direction and supervision the Market Street subway and the elevated railway in Philadelphia was built. He was graduated from Allegheny College in 1887, and served 3 years there as instructor, then entered the employ of the Thomson-Houston Company, Boston, Mass., for which he had charge of electric railway construction in Indianapolis and Toledo. In the latter part of 1891 he assisted in equipping the Harlem Bridge, Morrisania & Fordham Railway, now a part of the Union Railway, New York City, with electricity, and, in the following year was one of the engineers in charge of the electrical equipment of the Atlantic Avenue Railway, now a part of the Brooklyn Rapid Transit System. In 1893 he was appointed assistant to the chief engineer of the People's Traction Company, Philadelphia.

Earl Meckley, assistant city engineer of Allentown, Pa., has resigned to enter the automobile business at Hanover, Pa. Mr. Meckley is a graduate of Pennsylvania State College, and has been in the service of the city of Allentown for the past four years.

De Witt V. Moore has resigned from the office of district engineer, central district, Division of Valuation, Interstate Commerce Commission, to engage in consulting practice with offices at the Lytton Building, Chicago. He will specialize in valuation work, and cost analysis will be given particular attention. Mr. Moore's experience covers 10 years in railroad engineering, 10 years in railroad and structural construction as engineer and contractor, and a connection with the Division of Valuation, in the position mentioned, since its organization in 1913.

Edmund F. Saxton, recently assistant director of the Department of Wharves, Docks & Ferries of Philadelphia, and formerly chief engineer of The United Railways of Yucatan, including the port of Progreso, and, for over fifteen years in charge of testing laboratories, railroad location and betterment, reports, reinforced-concrete and bridge construction, docks, piers and harbor work, has opened offices to engage in a general consulting engineering practice at the Pennsylvania Building, Philadelphia. Special attention will be given to municipal problems, valuations, railways, ocean and river piers and wharves, design, testing and supervision, and the construction of general works.

Rudolph P. Miller was reappointed on Feb. 1 by the new Board of Aldermen of New York City, as expert to assist the committee on buildings in completing the revision of the building code. In the last two years the committee has, under Mr. Miller's guidance, revised practically the entire code with the exception of the sections relating to theaters, now to be taken up by the committee. Mr. Miller, before his appointment as superintendent of buildings of New York City in January, 1910, had a large consulting practice in New York City, most of it with architects and builders. From 1895 to 1906 he was connected with the building department in various capacities, and, in 1907, was made a member of the first committee on the revision of the code. Mr. Miller was graduated from Columbia University in 1888 with the degree of civil engineer.

Dr. Gilbert J. Fowler, recently professor of chemistry in the Manchester University of England, and the discoverer of the activated sludge process of treating sewage, sailed Jan. 22 for India to assume the professorship of applied chemistry at the Indian Institute of Science at Bangalore, Mysore, India. In a letter to T. Chalkley Hatton, chief engineer, Milwaukee Sewerage Commission, he states that his research work in connection with activated sludge and other sanitary questions will be carried on at his laboratory in Manchester under the direction of Mrs. E. M. Mumford, M.Sc., research fellow of the Board of Agriculture, who is working in conjunction with Mr. Ardern.

William B. Bennet, consulting engineer, of Niagara Falls, N. Y., has accepted appointment to the office of city engineer of that city. He will continue his consulting practice in addition to his new duties.

Jay A. Craven, sanitary engineer for the U. S. Public Health Service, Cincinnati, has been made assistant manager of the Terre Haute (Ind.) Water Company. Following his graduation from Purdue University he was for one year assistant to C. A. Jennings at the Bubbly Creek filter plant, Chicago, one year as chemist with the Omaha Water Company, three years as sanitary engineer for the Indiana State Board of Health, and one year with Morris Knowles, consulting engineer, Pittsburgh. At the directors' meeting when Mr. Craven's position was created, Dow R. Gwinn was re-elected president and general manager, J. L. Crawford, vice-president, J. I. Mandeville, secretary, and M. H. McLeen, treasurer.

R. W. Sharp, superintendent of waterworks, Rock Island, Ill., has resigned to accept a position with the Illinois Oil Company.

Capt. J. McLean Jasper, formerly assistant engineer with Alvord & Burdick, Chicago, and at present with the British expeditionary force in the 172nd Brigade Royal Field Artillery, "somewhere in France," sends engineering friends in Chicago the regulation war postcard on which is checked off the phrases, "I am well," "Letter follows at the first opportunity," and "Your last letter received." He has been in the trenches since early in December.

Prof. William Hubert Burr has reached the age of retirement, after 22 years of continuous service as professor of civil engineering at Columbia University. The Board of Trustees announced on Feb. 7 that his active work at the university will cease at the end of the present academic year. Professor Burr is a graduate of the class of 1872, Rensselaer Polytechnic Institute. After a few years in practice he became instructor at Rensselaer in 1875, and the next year was made head of the department of applied mechanics. In 1884 he became assistant to the chief engineer of the Phoenix Bridge Company, and later was general manager of that company. In 1892 he was made professor of engineering at Harvard University, and, in 1894, he accepted his present position at Columbia University, where he has had charge of the civil engineering department. Professor Burr's work as an author of text books and technical papers is well known. He has been a member of various commissions, including the commission on additional water supply for New York City, of which he was made chairman in 1903, and of both Isthmian Canal Commissions. He was a member of the board of advisory engineers for the New York State Barge Canal construction, and was appointed by President Cleveland on the board of engineers to investigate the feasibility of bridging the North River. He has acted in a consulting capacity on many large projects and bridges, and as consulting engineer to various New York City departments. He was engaged by the City of New York to investigate and report on the strength of the Queensborough bridge.

Group of Consultants on Industrial Efficiency Organized

A number of engineers and specialists in sales and advertising methods have become associated under the title of "The Consultants," with the McCall & Clarke Company, of 101 Park Avenue, New York, as managers. Each of the consultants is a specialist of standing in his particular line and is prepared alone or in consultation with his associates to prosecute investigations for the increase of the efficiency of manufacturing and selling organizations.

The gentlemen associated in the group, and their specialties are as follows: E. D. Anderson, automatic machinery; W. H. Chappell, production contractor; Francis W. Collins, industrial and financial investigations; John F. Daniell, retail and department store economics; Albert A. Dowd, machine shop practice; C. E. Knoeppel & Company, organization and management; E. St. Elmo Lewis, sales and advertising, market investigations; F. M. Williams, industrial chemistry. The McCall & Clarke Company will take care of the installation of cost systems and will make financial audits.

A fifty-two page 5 x 8-in. pamphlet, giving the experiences of these gentlemen and also containing three chapters from Mr. Knoeppel's book on "Practical Application of Efficiency Methods," has been prepared for distribution.

Lumbermen Pushing Publicity

That lumber is second only to steel in magnitude of production and must have publicity worthy of it, was the point made in a recent address of E. A. Sterling, of Chicago, manager of the trade extension department, National Lumber Manufacturers Association, before Michigan lumber dealers. Mr. Sterling briefly outlined the trade extension idea and traced its rapid development from a mass meeting of lumbermen in Chicago about a year ago. The spirit of lumber trade promotion is now widespread and is being taken up by manufacturers' and dealers' associations, city groups of lumbermen and individuals everywhere. Probably not less than $1,000,000 will be spent by the lumbermen this year in advertising and promoting their product.

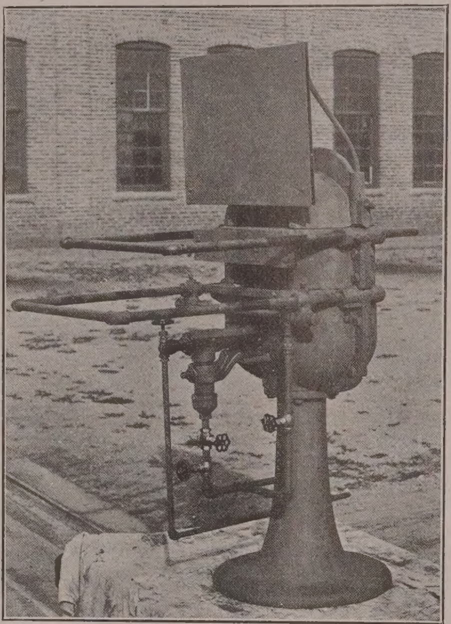
"Manufacturers of building materials which take the place of lumber have set the pace," said Mr. Sterling, "and the lumbermen must adopt similar selling methods or lose their market. We have only admiration for the progressive action of our competitors, yet, simply because the lumber industry is so big as to have lacked cohesion, is no reason why it should not now fight for its legitimate market." According to Mr. Sterling, "The lumbermen are now in the field, not in a spirit of crying down any other material, since all have their places, but to promote the use of lumber where lumber is best, and to secure safer and better wood construction in dwellings, commercial buildings and on the farms.

New Furnace for Heating Drill Steels Has Many Advantages

The new type of oil burning furnace illustrated herewith, used extensively for heating drill steel, is now made with a preheating chamber which greatly increases the capacity of the furnace. This preheater is a section which fits between the body and cover of the furnace of the former design. It is, therefore, a simple matter to attach this section to an old furnace by changing a few bolts. Referring to the illustration, it will be seen that the lower chamber is used for the final heating and the upper one for preheating. It is claimed that by the addition of the preheating feature, the space for heating is doubled, the heating capacity of the furnace is increased about 50 per cent and the efficiency of the furnace is increased correspondingly.

The type of burner now furnished with this furnace is suitable for either high or low pressure air. It has merely to be throttled for high pressures. When this is done it is said to be as efficient as burners designed especially for high pressures, while eliminating the noise common to such burners. The furnace burns petroleum or any of its oils, such as gasoline, kerosene, distillate, etc. Many advantages are claimed for oil heating. The steel cannot be injured by absorbing injurious elements such as sulphur, phosphorous and other impurities from the fuel, nor from unequal heating, as it is heated in a flame which imparts a uniform temperature. It is in full view of the operator at all times.

The floor space occupied by this new No. 3 Leyner furnace is 3 by 4 ft. No foundation is required, installation being complete when the air and oil supply pipes are connected. The absence of smoke, soot, dust, ashes and cinders is a convenience which is particularly appreciated in underground installations and in plants used in buildings. The manufacturers are the Ingersoll-Rand Company, of New York City.



OIL FURNACE PREHEATS DRILL STEELS

Business Notes

The Trussed Concrete Steel Company convention was held at the main plant at Youngstown, Ohio, Jan. 25-29.

The American Manganese Steel Company, of Chicago, Ill., has established a branch office in the Oliver Building, Pittsburgh.

The Waterworks Manufacturers' Association executive meeting that was scheduled for Feb. 8 was postponed and will be held at the Machinery Club, New York City, Feb. 16.

The Alliance Well Company, Turks Head Building, Providence, R. I., has succeeded to the business of the Roy S. Barker Company, well drillers, of that city. Roy S. Barker is president of the new company.

Walter B. Snow and Staff, advertising agents and publicity engineers, of Boston, have recently added to their organization Mr. Charles W. Burrage, formerly of the instructing staff of the Massachusetts Institute of Technology.

The Original Gas Engine Company, manufacturer of gasoline engines and contractors' equipment, of Lansing, Mich., will be known hereafter as the Ideal Engine Company. The change in name was decided upon at the annual meeting of the stockholders of the company.

Albert H. Scherzer, vice-president of the Scherzer Rolling Lift Bridge Company, died in Chicago, Jan. 28, at the age of 51 years. He was a graduate of the Technical School of Zurich, Switzerland, and of the Union College of Law, Chicago. He practised law until the death of his brother William, the inventor of the Scherzer rolling lift bridge.

W. L. Macatee & Sons, cement dealers, of Houston, Tex., were visited some time ago by a man who represented himself as being connected with a concern engaged on contracts for plain and decorative plastering, who stated he was contemplating figuring on some work in that city, and was desirous of obtaining prices. This done, he left the office, but later in the day returned and the firm cashed a check for him. The check was not honored by the bank upon which it was drawn, and inquiry in the cities at which the stranger's employers were said to have offices failed to locate any such concern.

The Veteran Employees' Association of the Westinghouse Electric & Manufacturing Company, at its annual banquet, held Jan. 29 in the Fort Pitt Hotel, Pittsburgh, Pa., presented to the company a bronze memorial tablet of the late George Westinghouse, founder of the numerous industries bearing his name. About 450 veterans were present. The memorial tablet is 4 by 3 ft., made of solid cast bronze, and weighs about 300 lb. It shows a bas-relief likeness of Mr. Westinghouse taken from one of his best photographic poses, seated in an armchair, and bears the inscription "GEORGE WESTINGHOUSE, Master Workman, Inventor, Founder, Organizer, 1846-1914." It will be placed in the reception room of the East Pittsburgh works of the electric company. The presentation was made on behalf of the veterans by Charles F. Scott, consulting engineer, and professor of electrical engineering at Sheffield Scientific School, Yale University, and was accepted on behalf of the company by Guy E. Tripp.

Trade Publications

The following companies have recently issued trade literature:

E. J. Whalen, Syracuse, N. Y., catalog, 20 pages, forms for concrete highway culverts.

Homestead Valve Manufacturing Company, Pittsburgh, catalog, 40 pages, straightway, three and four way, and angle valves from ⅛ to 6 in. in size.

New Way Motor Company, Lansing, Mich., catalog D-16, 40 pages, New Way horizontal, portable and pumping engines, single and double opposite cylinders, and special attachments transmission, gas generation, etc.

Barber Asphalt Paving Company, Philadelphia. Booklet, 6 x 8¼ in., 20 pages, illustrated. "The Asphalt Primer and Colloidal Catechism" represents, as the manufacturer says, an attempt to put a different chemical proposition into a form that will appeal to and be understood by the layman. The treatment is in the form of questions and answers on the history of road construction and on definitions relative to asphalt and its chemical nature. There is information in it that will interest everyone, because it is human. It includes accounts of the works of Egyptian and Roman road builders of past ages and theoretical explanations of stratum formation of asphalt.

Bausch & Lomb Optical Company, Rochester, N. Y. "Metro Manual," a handbook for engineers, 199 pages and appendix. This is a veritable treatise on surveying instruments and their use, including descriptions of instruments, adjustments, surveying methods, tables, formulas—far more useful information than can be even mentioned in the small space available here. The fact that detail information regarding the company's individual products is scattered through the pages does not detract from the merits of the book, especially as generous space has been given to instruments and devices with which the company seemingly has nothing to do.